Medical Library
SEP 19 1941

SERIES 3, Vol. 24, No. 9 SEPTEMBER, 1941

AMERICAN JOURNAL OF OPHTHALMOLOGY

CONTENTS

		PAGE
Biochemistry of the lens, XV	*J. G. Bellows and H. Chinn*	979
Oculogyric crises	*R. M. Klemme*	1000
Hyperostosis of the orbit	*W. L. Benedict*	1005
Hereditary craniofacial dysostosis	*E. A. Vorisek*	1014
Management of strabismus	*J. B. Hitz*	1019
What can be expected of orthoptic training?	*E. Knauber*	1022
Gonioscopy after cyclodialysis	*S. T. Clarke*	1026
Bitôt's spots in Trinidad	*V. M. Metivier*	1029
The chemotherapy of trachoma	*A. R. McKelvie, R. Kirk, and H. J. Holder*	1035
Convergence insufficiency	*B. Cushman and C. Burri*	1044
Wollaston and hemianopsia	*J. E. Lebensohn*	1053
The San Francisco orthoptic laboratory	*F. C. Cordes*	1057
Luckiesh-Moss test-chart illuminator	*M. Luckiesh and F. K. Moss*	1061

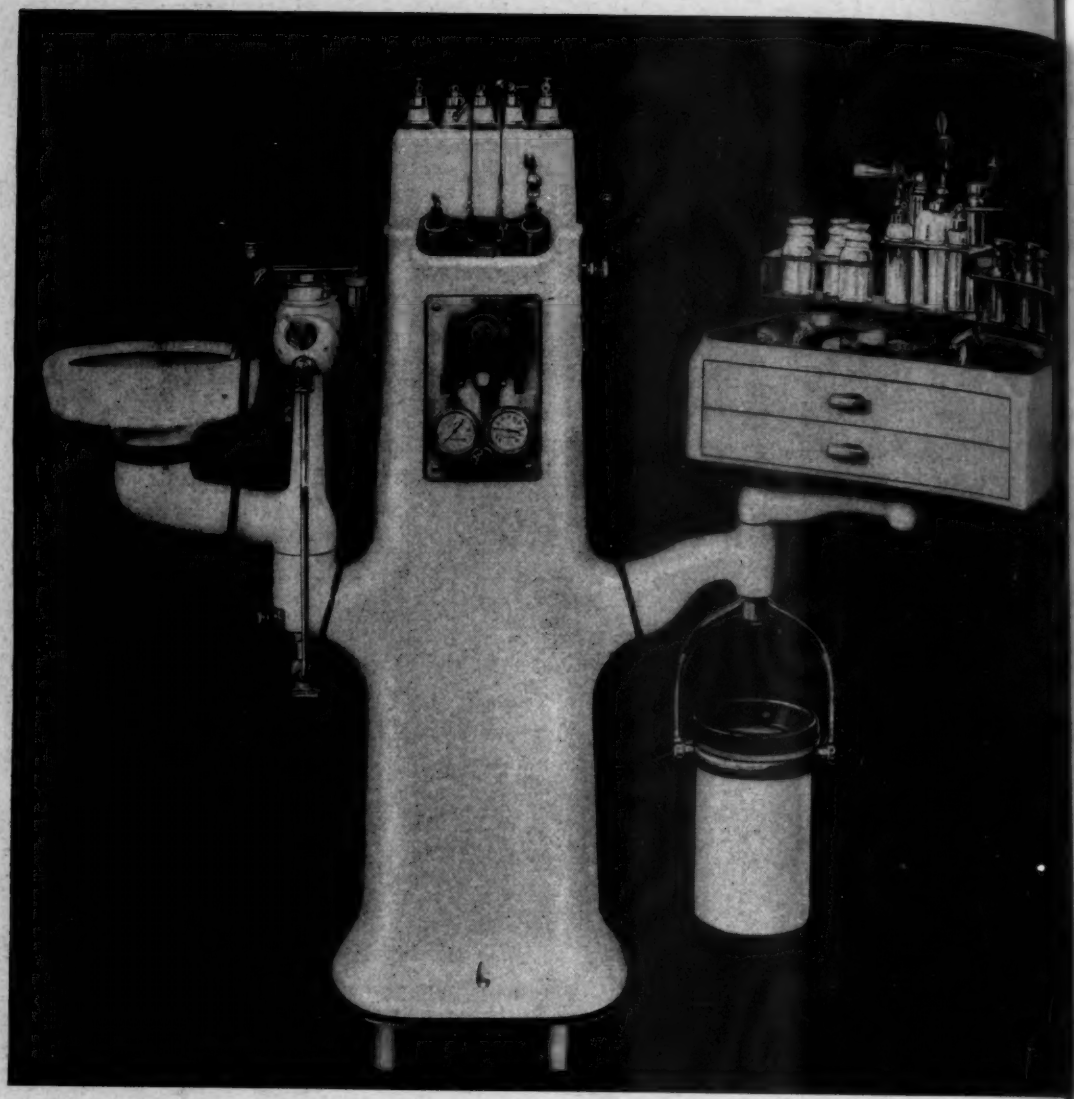
DEPARTMENTS

Editorials	1063
Book Notices	1071
Obituary	1072
Abstracts	1073
News Items	1104

For complete table of contents see advertising page V

Copyright, 1941, Ophthalmic Publishing Company, 837 Carew Tower, Cincinnati, Ohio

Subscription price in United States ten dollars yearly. In Canada and foreign countries twelve dollars. Published monthly by the George Banta Publishing Company, 450 Ahnaip Street, Menasha, Wisconsin, for the Ophthalmic Publishing Company. Subscription and Editorial Office: 837 Carew Tower, Cincinnati, Ohio. Entered as second class matter at the post office at Menasha, Wisconsin.



Modern Equipment for Present Day Needs

We take real pleasure in offering to our customers this new, fine, modern Ear, Nose and Throat Unit. Exclusively designed by Ritter, it has all the examination, treatment, and operating facilities you need instantly accessible—at your finger tips—to conserve your time, eliminate fatigue, and add to your own and your patients' comfort.

You are invited to inspect this mod Ear, Nose and Throat Unit, together w its companion piece, the new electric controlled Motor Chair.

These units will be on display soon i number of the larger cities. Write for scriptive literature which gives comp specifications and prices.

RIGGS OPTICAL COMPANY

Distributors of Bausch & Lomb Products

GENERAL OFFICES, CHICAGO, SAN FRANCISCO; BRANCHES IN PRINCIPAL WESTERN AND MID-WESTERN CITIES

AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 24 SEPTEMBER, 1941 NUMBER 9

BIOCHEMISTRY OF THE LENS

XV. STUDIES ON THE SWELLING OF THE ISOLATED LENS*

JOHN G. BELLOWS, M.D., PH.D., AND HERMAN CHINN, PH.D.
Chicago

Although water is quantitatively the most important constituent of almost all tissues, its function as a vital element of the cell was little studied until within relatively recent years. Fortunately, the role of water in living processes is now under active investigation and a clearer insight of the nature and action of "biological" water is gradually materializing. It is becoming more and more evident that at least some of the water in biological systems possesses certain properties not ordinarily associated with water in bulk. Most investigators now agree that a portion of the water is intimately bound to the organic structures of the cell (especially to protein) in such a manner that it loses many of the characteristics of "free" water. Thus, the "bound" water shows changes in heats of hydration, dielectric constants, freezing tendencies, and the like. This water is bound to certain polar groups of the protein molecule with such tenacity that hundreds of thousands of pounds pressure per square inch is necessary to free it. In many instances it will resist freezing even at temperatures below −100°C., and will remain adherent to the protein after heating for several hours above 200°C. The water held in this manner is extraordinarily constant and varies little with changes of temperature, pH, salts, and so on. The remainder of the water in the tissues varies primarily with the osmotic pressure of the system, although the capillarity of the fibers or other factors may play minor roles.

If a cell or aggregate of cells be placed in water, it will usually swell, indicating water uptake. This swelling is the summation of the two processes suggested above; namely, (1) the hydration of the polar groups in the protein molecule, and (2) entrance of water to equalize the higher internal osmotic pressure. The water attracted by the latter process is loosely held and can be profoundly influenced by changes in the environment of the cell. In the body, alterations of the water equilibrium are dependent largely upon this factor.

The water equilibrium of the crystalline lens is of even greater interest than that of most tissues, since changes in the water content are immediately reflected by refractive errors and diminished transparency. Kunde,[1] in 1857, was the first to observe that lenses became cataractous when they were dropped into hypertonic solutions of NaCl or sugar. That this was due to water removal was apparent by the ease with which the lenses regained their transparency when the solution was replaced with distilled water. Deutschmann[2] extended this work and found that opacities resulted after immersion of sheep and

*From the Departments of Ophthalmology and Chemistry, Northwestern University Medical School. Presented at the Twelfth annual meeting of the Association for Research in Ophthalmology, at Cleveland, June 3, 1941.

pig lenses in either 1.75-percent NaCl solution or 5-percent glucose. He reported a loss in weight in concentrations less than 1 percent. No change was noted with 1-percent saline. However, Manca and Ovio[3] found that 1.2-percent saline and not 1 percent was isotonic. Subsequent work by Römer[4] demonstrated that 1.2-percent NaCl was actually hypertonic, but that water would nevertheless eventually be drawn into the lens. This observation was highly significant, demonstrating as it did that the osmotic pressure of the lens is not the only factor concerned in swelling. Fischer[5] emphasized this point in his studies of lens swelling and drew attention to the distinction between isotonic and isoösmotic solutions. He points out the fallacy of assuming the lens to act merely as a capsule filled with saline (as had Leber[6] and Wessely[7]) without considering the water-binding capacity of the enclosed protein.

During swelling, the water must pass through the lenticular capsule and penetrate the capsules surrounding each individual fiber. The permeability of these capsules thus acts as an important control in the alteration of the water content of the lens. Since the lenticular capsule is more amenable to direct manipulation than are the capsules of the individual fibers, its permeability has been the more thoroughly investigated. Friedenwald[8] has studied the effect of various compounds upon the isolated capsule. His findings in general were corroborated by Gifford *et al.*,[9] who measured the penetration of various organic and inorganic compounds into the lens. We undertook the present investigation in an attempt to relate more closely the various factors involved in lens swelling.

Experimental

Eyes from freshly slaughtered cattle were used in all experiments unless otherwise stated. They were kept chilled but not frozen during transit, and were dissected immediately upon arrival. The lenses were removed, care being taken to avoid any injury to the capsule, and placed in pooled samples of filtered vitreous humor from the same batch of eyes. The lenses were kept in the vitreous for one hour to equalize any slight differences in temperature and osmotic pressures of the individual lenses. At the end of this period, the lenses were removed, dried thoroughly by rolling gently on filter paper, placed in a test solution of known weight and then weighed. At the conclusion of the test period, the lenses were removed, carefully dried, and again weighed. Originally 0.9-percent Tyrode's solution was employed instead of the vitreous, but the lenses were found to swell quite markedly. Even when more concentrated solutions of Tyrode were used some swelling resulted, so that after two hours' immersion in 1.50-percent Tyrode's solution, an approximate swelling of 1 to 2 percent resulted. With the freshly filtered vitreous, less than 0.5-percent increase occurred during the same interval.

Although the importance of the lens swelling due to imbibition forces of the protein molecules cannot be minimized, it is nevertheless the osmotic forces, that account for most of the water transfer. Considerable work has been done to show that the transfer of water between a cell and an anisotonic medium takes place primarily because of the differences of osmotic pressure between cell contents and the surrounding medium. In the more simple cellular systems, the passage of water follows quite closely the classical laws of osmosis and diffusion. As the system becomes more complex, deviations from these laws become more striking, and the applicability only approximate. With certain marine ova, red blood cells, and some plant-tissue cells, it was found

that the cells might be employed as delicate osmometers so long as the membrane was not injured. The simpler the cellular system studied the more rigid the adherence to the laws of diffusion and osmosis. An excellent review of this subject has been prepared by Lucké and McCutcheon.[10]

To demonstrate the osmotic effect in the swelling capacity of the lens, we placed lenses treated in the manner described above into concentrations of vitreous humor varying from 0 (distilled water) to 80 percent. After intervals of 2 to 360 minutes, the lenses were removed, dried, and weighed. Upon removal of the lens, it was noted that there was a marked accumulation of water, subcapsularly, so that the lens substance often seemed to be floating under the capsule. This was especially noticeable in the lenses exposed for the longer periods. The percentage increase, calculated on the basis of the original weight, is reported in table 1.

TABLE 1

RATE OF LENS SWELLING

Time (min.)	Percentage Vitreous				
	0	20	40	60	80
	Percentage increase in weight				
2	1.25	0.73	0.75	0.56	0.38
5	2.61	1.64	1.37	1.31	0.79
15	4.80	3.65	2.84	2.11	1.17
30	5.62	4.60	4.21	3.14	1.92
60	7.55	5.82	5.70	3.69	2.29
120	11.56	7.66	6.91	4.21	3.61
240	14.92	10.52	9.06	7.12	5.43
360	15.68	11.47	10.91	9.31	6.24

Since the quantity of any substance penetrating a membrane depends more upon the area of the membrane than upon the weight of the tissue enclosed therein, we recalculated these data on the basis of the surface areas of the lens. As can be seen from figure 1, the diffusion of water across the membrane was roughly a parabolic function of the time. A slight error is entailed in this representation since a density of 1.00 was used for water instead of the more exact value of 0.997 at 25 degrees. The increase in the weight of the lens was most rapid during the first 30 minutes, after which time the penetration of the water into the lens became quite slow for all concentrations of vitreous. This rapid decrease in the rate of swelling can perhaps be seen more readily if the volume of water entering the cell per minute be plotted against the various intervals during the experiment. Figure 2 shows this relationship. The times plotted along the abscissa are the halfway values of successive experimental intervals. The

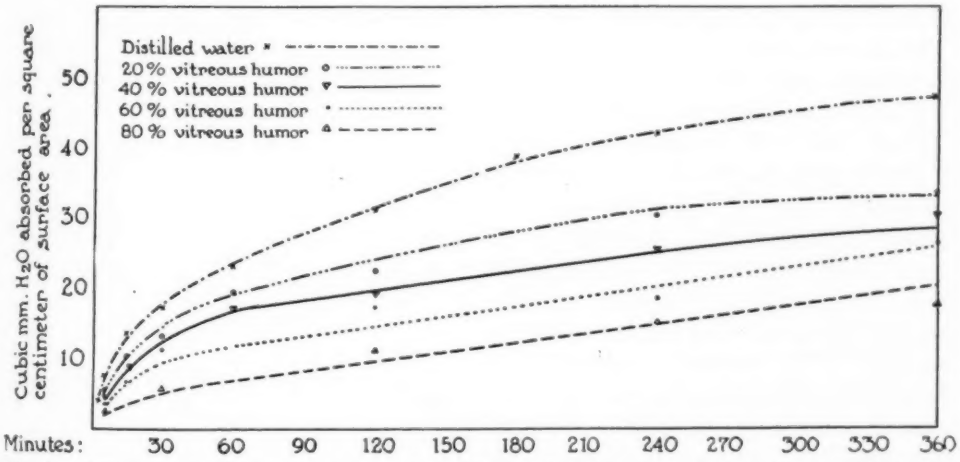


Fig. 1 (Bellows and Chinn). Rate of water diffusion into lens immersed in hypotonic solution.

ordinate represents the average increase during that period. This graph shows the precipitous decline in water penetration

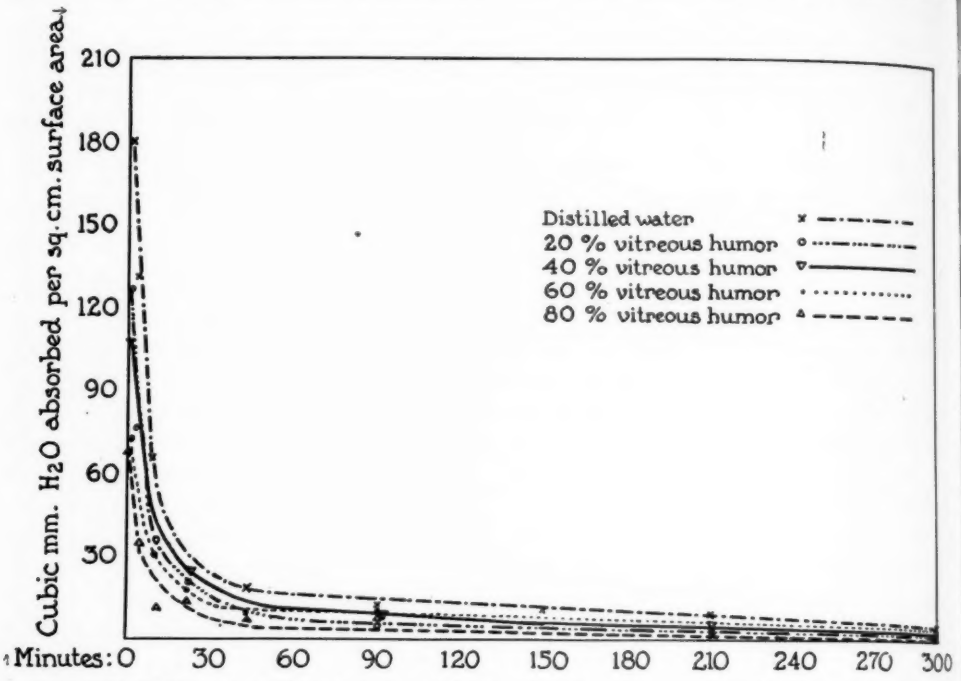


Fig. 2 (Bellows and Chinn). Water diffusion into lens at successive intervals of time.

as the experiment progressed. Within 30 minutes the rate of entrance had fallen to a value only 10-20 percent of the amount entering during the first few minutes. At the end of the 30-minute period the drop became more gradual.

To determine the volume of water passing across a unit area of capsule, it was necessary first to find the surface area of the lens. The only values we were able to discover in the literature were those reported by Gifford and co-workers, *loc. cit.*, on the average surface area of ox lenses. These values had been determined from a knowledge of the weight and specific gravity of the lens, and by assuming the lens to be perfectly spherical. As comparative values were all that were desired in their experiment, these figures were sufficient. For the determination of absolute values, we calculated the area graphically as illustrated in figure 3. The horizontal diameter and the anterior and posterior portions of the axis were determined with calipers. The accuracy of the surface-area value is dependent upon these measurements. These measured val-

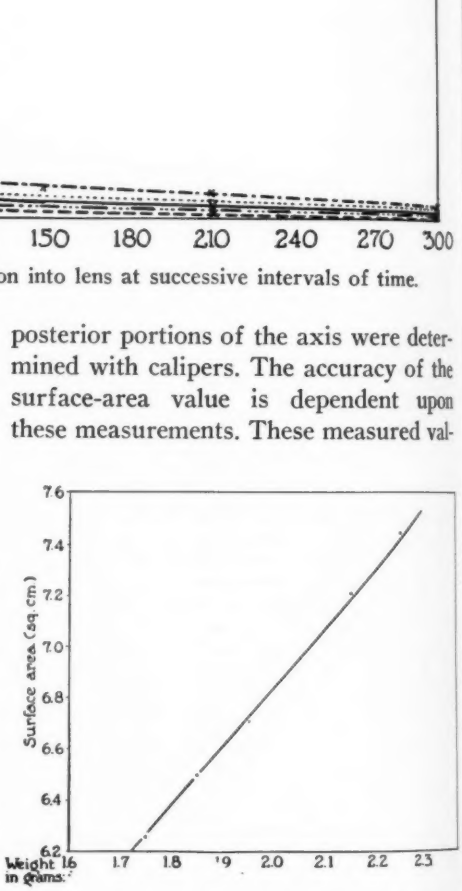


Fig. 3 (Bellows and Chinn). Relation of lens weight and its surface area.

ues were multiplied by a convenient factor (usually 5) to minimize errors in the construction of the figure. A perpendicular line, CD, bisecting the diameter, AB, at O was constructed. The anterior axis (multiplied by the proper factor) was laid out on the perpendicular at E. A perpendicular bisector, FG, was erected on the line EB. The point of intersection, H, of the two perpendicular bisectors determined the center of a circle enclosing the triangle ABE. Thus HE is the radius of curvature of the anterior surface of the lens. The radius of curvature, IJ, of the posterior surface was similarly determined.

The areas of the anterior and posterior zones were calculated separately from the formula:

$$S = 2\pi rh$$

where r is the radius of curvature, and h the corresponding perpendicular distance from the pole to the axis AB. The sum of the areas gives the total area of the lens.

To obviate the necessity of undergoing a similar computation for each lens studied, we attempted empirically to correlate the weight of the lens with the surface area. Figure 4 represents the average of some 200 to 250 lenses. For the weight range including 95 to 98 percent of the lenses examined, an approximate straight-line relationship was discovered. Individual deviations from these average figures in most cases were not great.

Using artificial membranes or simple unicellular systems, it was shown by Lucké, Hartline, and McCutcheon[11] that the rate of transfer of water across a membrane could be expressed according to the equation:

$$\frac{dV}{dT} = kS(P\text{-}P_{ex})$$

where $\frac{dV}{dT}$ is the change in volume per unit time, S is the surface area, P is the osmotic pressure in the cell, P_{ex} the osmotic pressure of the surrounding medium, and k is a constant depending upon the membrane. Although the surface area as well as the internal osmotic pressure of the lens changes during swelling, this variation is relatively small and it was thought that an approximation of k could be obtained with the nonintegrated form of the equation expressed above. This should be especially true for the shorter intervals of time in which alterations of surface area and osmotic pressure are very slight. As can be seen from table 2, however, the values for K (cubic millimeters of water passing through each square centimeter of membrane per minute per atmosphere difference in osmotic pressure) showed little consistency.

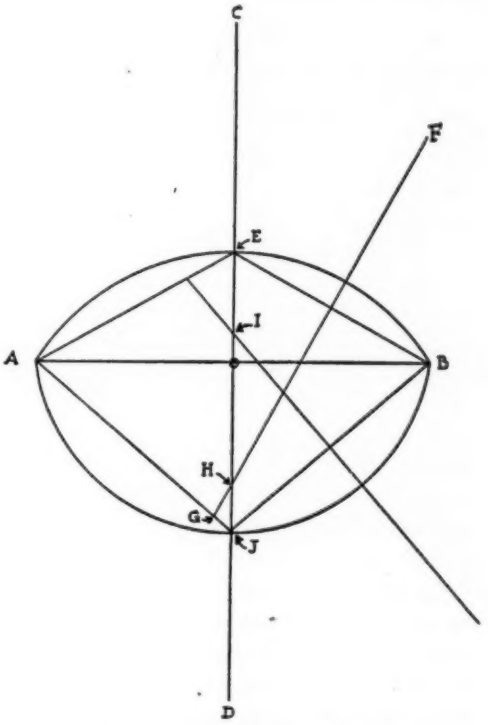


Fig. 4 (Bellows and Chinn). Determination of the surface area of the lens.

The passage of water into the lens due

to osmotic pressure differences is a more complicated process than in the systems considered above. As has already been pointed out, the passage of water per unit area of surface varied inversely with the osmotic concentration of the external solution. However, this variation was not constant, and attempts to calculate a permeability constant that would hold equally for all osmotic pressure variations were unsuccessful. A number of reasons might be advanced to explain why the isolated lens is not a perfect osmometer and how it differs from the simple systems obtained with artificial membranes or unicellular organisms. In the first place, the lens consists of thousands of individual fibers, each possessing its own membrane and serving as a miniature osmometer. Thus, water passing across the lens capsule is not homogeneously distributed to produce an equal dilution throughout the lens. The water, on the contrary, must diffuse through the membranes of the individual cells. Consequently, as diffusion progresses no specific osmotic pressure can be attributed to the lens as a whole, for at any point of time there is a gradation of osmotic pressures ranging from the value of the external medium to that of the cells in the nucleus of the lens. Secondly, there is the effect of the protein within the lens. The lens contains the highest concentration of protein of any tissue of the body, and, as Fischer has already emphasized, the water bound by this protein cannot be disregarded. In the simpler systems in which permeability has been studied, this factor is of little importance.

TABLE 2

VARIATION OF PERMEABILITY CONSTANT OF LENS (mm.³/cm.²/min./atmosphere osmotic-pressure difference)

Time (min.)	Percentage Vitreous				
	0	20	40	60	80
2	0.245	0.182	0.376	0.244	0.374
5	0.202	0.193	0.187	0.257	0.318
15	0.125	0.117	0.127	0.138	0.167
30	0.0764	0.0743	0.0874	0.107	0.124
60	0.0571	0.0605	0.0638	0.0625	0.0747
120	0.0351	0.0340	0.0369	0.0527	0.0613
240	0.0239	0.0215	0.0242	0.0225	0.0376
360	0.0176	0.0150	0.0195	0.0266	0.0308

Furthermore, the thickness of the lenticular capsule, as well as of the individual fiber capsules, is changing continuously during swelling, with the elasticity of these membranes undergoing a concomitant alteration. The lens fibers are more closely packed in the nucleus than in the cortex, impeding further the passage of water within this region. Water is absorbed across the lens capsule more rapidly than it can be removed centripetally, which causes it to collect subcapsularly. Since the concentration of this body of fluid is very similar to that on the exterior, the diffusion gradient is low, and the rate of absorption becomes even slower. All these factors and possibly others complicate any attempt to treat the tendency on the part of the lens to absorb water from a hypotonic system as dependent entirely upon the simple physical laws of diffusion and osmosis.

The precipitous decline in the absorption of water at various intervals can be explained largely by a rapidly decreasing diffusion gradient across the lens capsule (fig. 2). This gradient is decreased by the diffusion both of salts from the lens and of water into the lens. The factors discussed above play roles of varying importance in determining the eventual equilibrium of the lens and its medium.

Löwenstein[12] postulated that senile cataract might result from an increased permeability of the capsule in old age. On the contrary, Friedenwald[8a] presented experimental evidence to show that the permeability of the capsule *decreases* with age. This was confirmed by Gifford et al., *loc. cit.*, using a different technique. These findings are in harmony with the well-

TABLE 3

EFFECT OF AGE ON SWELLING OF LENS

Time (min.)	Original Weight of Lens (gm.)		Weight of Water Absorbed (gm.)		Percent Water Absorbed		Water Absorbed per Sq. Cm. ($mm.^3$)	
	Calf	Cattle	Calf	Cattle	Calf	Cattle	Calf	Cattle
60	0.975	2.142	0.187	0.167	19.20	7.16	44.9	23.4
120	1.094	1.930	0.242	0.225	21.79	11.56	51.9	33.7

known fact that the capsule becomes thicker with age. We compared the swelling of calf lenses with those of beef and found a similar dependency upon the age of the animal. That the swelling was markedly diminished in older lenses is apparent from table 3. The water uptake by the calves' lenses was approximately double that of the beef lens during the corresponding period.

Our results offer indirect confirmation of the work of Friedenwald and Gifford. It seems likely that the increased water uptake of the younger lenses can be largely explained by an increased permeability of the capsule. Nevertheless, it should be remembered that the protein as well as the salt composition of the lens changes both qualitatively and quantitatively with age[13] so that the swelling may be dependent partially upon this factor. Caution should be exercised in all swelling experiments against attributing too close a parallelism between water uptake and capsular permeability.

It has been shown repeatedly that the swelling of most biological material increases with a rise in the temperature. This has been demonstrated for various plant cells,[7,14] sea-urchin eggs,[11,15] erythrocytes,[16] and other plant and animal tissues. We tested the effect on the swelling of the lenses of temperatures ranging from 6 to 46°C. The effect of these temperatures produced some rather puzzling results. For temperatures from 16 to 46 degrees there was a slight but rather consistent increase in swelling with rise in temperature. At 6 degrees we unexpectedly found a swelling more marked at each vitreous concentration than the corresponding values obtained at temperatures through 36°C. inclusive. Table 4 shows the milligrams of water per square centimeter of surface entering the lens at the various temperatures during a two-hour test period.

A possible explanation for the paradoxical situation at 6°C. might be deduced from the various effects of temperature upon cells and their surrounding medium. The viscosity of water decreases with a rise in temperature, and the permeability of most membranes seems to increase with a rising temperature. Both of these alterations would result in an increased water

TABLE 4

EFFECT OF TEMPERATURE ON SWELLING OF LENS

Percent Vitreous	Milligrams of Water Absorbed per Square Cm. Surface				
	6.0°±1.0	16.0°±1.0	26.0°±1.0	36.0°±1.0	46.0°±1.0
80	14.6	11.9	12.1	10.9	14.9
60	16.9	13.8	19.0	15.2	21.5
40	24.3	19.2	20.3	21.7	25.7
20	27.0	21.9	22.6	26.7	30.3
0	48.5	22.2	33.2	37.1	35.8

uptake. Opposing these changes is the decreased osmotic pressure of the cell at higher temperatures. This decrease results from the greater base-binding capacities of proteins at higher temperatures. This has been experimentally verified for erythrocytes by Jacobs[17] and for sea-urchin eggs by Fauré-Fremiet.[18] These factors do not necessarily vary equally with changes in temperature. At higher temperatures the increased water uptake resulting from viscosity and permeability alterations more than overcomes the shrinking tendency due to a decreased osmotic pressure of the cell. For slight changes, Northrop, *loc. cit.*, has shown viscosity alterations to be the most important factor. At lower temperatures the increased osmotic pressure due to the lowered base binding by proteins might counterbalance the increased viscosity and decreased permeability of the lens so that swelling would result.

Similar alterations in the water balance of the lens might possibly be a factor in the pathogenesis of cold cataract. This condition results more readily and at a higher temperature in young than in adult animals. It is significant that the amount of soluble proteins of the lens in the young animal is much greater than in older animals.[19] Conceivably differences in the base-binding capacities of these proteins might account for the changes observed in the lenses of different ages. At freezing temperatures, the formation of ice crystals might mechanically traumatize the capsule, resulting in increased permeability. Further experimental work is necessary to elucidate the mechanism of cold-cataract production.

The effect of the various electrolytes upon the biological activity of cells is well known and has been extensively investigated.[20] Permeability is one of the cellular properties that is profoundly altered by the presence of electrolytes. The effect of the various ions on the permeability of the lenticular capsule has been studied by Friedenwald and Gifford and co-workers. The ionic action on lens swelling was investigated most comprehensively by Fischer, *loc. cit.* Both Friedenwald and Gifford *et al.* showed that $CaCl_2$ produced a marked reduction in permeability of the lens. Fischer varied the concentrations of various salts from molar to 0.001 M and determined the percentage swelling for periods up to 19 hours. He found that the swelling was greatest when Na^+ was the cation, followed by K^+, NH_4^+, Mg^{++}, and Ca^{++}, respectively. Cyanide had the most marked anion effect, followed in descending order by thiocyanate, bromide, phosphate, acetate, citrate, nitrate, iodide, and sulfate. An objection to Fischer's experiments is the fact that he compares all electrolytes in equal molar solutions rather than in isoösmotic concentrations. The swelling is dependent not primarily upon the molarity of the solution but upon the number of particles in the solution. Thus, a molar solution of $ThCl_4$ would be osmotically equivalent to 1.25 M $AlCl_3$, 1.67 M $BaCl_2$, 2.50 M NaCl, and 5.0 M glucose.

We determined the swelling effect of isoösmotic solutions on the lens. These solutions were so prepared as to have an osmotic pressure equivalent to that of 0.02 M nonelectrolyte: $aC = 0.02$, where a is the number of particles in solution (ions or molecules) and C is the molarity of the solution. Nonelectrolytes were employed in 0.02 M concentration; electrolytes of type A^+B^- in 0.01 M concentration; $A^{++}B_2^-$ or $A_2^+B^{--}$ of 0.0067 M concentration; $A^{+++}B_3^-$ or $A_3^+B^{---}$ in 0.005 M concentration; and $A^{++++}B_4^-$ in 0.004 M solutions. The osmotic pressure of such solutions was approximately 0.45 atmospheres. As a control, the swelling in 6-percent vitreous (6 c.c. normal filtered vitreous made up to 100 c.c.) was deter-

mined. At this concentration, the vitreous was isoösmotic with the test solutions. The effect of the various electrolytes on lens swelling is presented in table 5 and whenever possible compared with the data of Fischer. In order to include this comparison, we have recalculated some of Fischer's values and converted them in the light of the discussion above. The figures marked with asterisks must be considered only as approximations.

Of all the anions tested, only citrate showed a decrease in the swelling when compared with the 6-percent vitreous control. Nitrate had little or no effect on the swelling. Of the anions causing an increased swelling, cyanide was the most marked followed by oxalate, thiocyanate, iodide, sulfate, bromide, and chloride, in that order. It is interesting to recall in this connection that Gifford *et al.* reported an increased permeability with cyanide, whereas Friedenwald observed a decreased permeability. Fischer found the swelling to be strikingly increased with cyanide. With every salt tested, the lens swellings obtained by Fischer were greater than ours, although the sequence was approximately the same. The reason for the absolute difference is not clear. Since age and temperature have already been shown to modify the swelling of the lens, it is possible that the variations may be explained partially by these factors.

The cations seemed to have a greater range of action upon the lens. Swelling during the two-hour period varied from 26 percent ($SnCl_4$) to 5 percent ($HgCl_2$). Most of the compounds tested increased the swelling tendency of the lens. The swelling in $SnCl_4$ solution was some 17 percent more than that obtained by the control during the same period. This marked uptake of water cannot be accounted for by the acidity of this solution. In those instances in which the same cations of different valences were employed ($SnCl_2$ and $SnCl_4$, $FeCl_2$ and $FeCl_3$) the greater swelling occurred with the higher-valence ion. However, that high valence alone does not necessarily cause an increase in the swelling tendency of the lens is apparent from the value obtained with $ThCl_4$. Only a slight increase in swelling resulted, which was less than that occurring with many univalent cations. It is interesting to note that the swelling activity of the halogen series of sodium salts varied inversely with the molecular weight. Sodium iodide caused the greatest swelling, bromide and chloride produced almost identical swellings, and fluoride

TABLE 5

IONIC EFFECT UPON SWELLING

Solution	Molarity	Increase in Weight of Lens percent	Fischer's Values percent
Sodium cyanide	0.0100	18.38	38.5
Sodium oxalate	0.0067	13.35	
Sodium thiocyanate	0.0100	12.28	19.2
Sodium iodide	0.0100	11.65	12.1
Sodium sulfate	0.0067	10.55	14.0*
Sodium bromide	0.0100	10.45	15.2
Sodium chloride	0.0100	10.46	14.9
Sodium nitrate	0.0100	9.73	13.1
Six-percent vitreous		9.38	
Sodium fluoride	0.0100	9.16	
Sodium citrate	0.0050	7.56	13.7
Stannic chloride	0.0040	26.21	
Stannous chloride	0.0067	22.68	
Aluminum chloride	0.0050	22.26	
Cadmium chloride	0.0067	16.72	
Ferric chloride	0.0050	15.90	
Potassium chloride	0.0100	13.35	14.2
Ferrous chloride	0.0067	13.03	
Lithium chloride	0.0100	12.62	
Cobaltous chloride	0.0067	12.39	
Ammonium chloride	0.0100	11.07	13.2
Thorium chloride	0.0040	10.68	
Sodium chloride	0.0100	10.46	14.9
Thallium chloride	0.0100	9.40	
Six-percent vitreous		9.38	
Manganous chloride	0.0067	9.23	
Magnesium chloride	0.0067	8.78	11.7*
Barium chloride	0.0067	8.19	
Cupric chloride	0.0067	8.08	
Nickelous chloride	0.0067	7.93	
Strontium chloride	0.0067	7.46	
Calcium chloride	0.0067	7.36	9.5*
Mercuric chloride	0.0067	5.13	

* Values only approximations.

TABLE 6

EFFECT OF ACIDS AND ALKALIES UPON SWELLING

	1 N			.1 N			0.01 N			0.001 N			0.0001 N		
	Swelling %	pH at start	pH after 2 hrs.	Swelling %	pH at start	pH after 2 hrs.	Swelling %	pH at start	pH after 2 hrs.	Swelling %	pH at start	pH after 2 hrs.	Swelling %	pH at start	pH after 2 hrs.
Hydrochloric acid	−0.57	0.40	0.50	16.28	1.20	1.45	21.24	2.15	2.90	11.38	3.10	6.40	9.56	4.15	6.70
Sulfuric acid	—	—	—	18.84	1.25	1.30	7.31	2.25	2.35	7.02	3.35	3.40	10.55	4.20	6.25
Nitric acid	−1.11	0.10	0.35	7.30	0.90	1.10	30.4	2.00	2.10	10.64	2.90	3.50	12.39	3.75	6.00
Acetic acid	—	—	—	16.01	2.95	3.10	13.27	3.45	3.80	9.94	4.15	4.80	11.66	5.00	6.50
Phosphoric acid	burst	1.45	—	27.35	1.95	2.10	10.27	2.50	2.85	10.77	3.20	5.30	—	—	—
Lactic acid	burst	2.15	—	34.44	2.65	2.65	11.93	3.15	3.40	10.69	3.80	4.55	—	—	—
Oxalic acid	—	—	—	1.87	1.15	1.20	5.06	1.85	1.85	8.21	2.65	2.80	10.53	3.40	5.00
Sodium hydroxide	burst	12.8	—	burst	—	—	44.18	11.60	11.65	13.79	10.25	10.00	—	—	—
Potassium hydroxide	burst	12.7	—	84.25	11.65	11.65	26.49	11.20	11.20	12.12	10.20	6.85	11.77	9.50	6.35
Ammonium hydroxide	—	—	—	—	—	—	27.12	10.40	10.20	10.96	9.20	8.90	—	—	—

actually caused a slight decrease from the control value. We had hoped that thallium chloride would produce changes in the water uptake since feeding of this element will produce cataractous changes in the lens.[21] However, the swelling within two hours was entirely normal.

In general the sequence of ionic activity followed that of the lyotropic series first studied by Hofmeister.[22] The decreased swelling with calcium, reported by Fischer, was confirmed. We noted further that strontium and barium—members of the same periodic table as calcium—caused a similar decreased swelling of the lens. The swelling inhibition by these cations varied inversely with their molecular weight. Copper and nickel also produced significant decreases. The lowest swelling obtained with any compound was that with mercuric chloride. Mercuric salts are effective protein precipitants, so that its action was probably of this nature, altering the protein so greatly that its normal permeability was abolished.

The acidity or alkalinity of a solution effects profoundly the swelling tendencies of proteins. Fischer investigated the effect of various acids and alkalies upon the swelling of the lens. He concluded that swelling was dependent upon the specific character of the acid and not upon the hydrogen-ion concentration, since more water was taken up when the lens was immersed in weakly dissociated acids than in strongly dissociated ones. Widely dissimilar curves were obtained for the various acids. The pH values of the solutions were not reported. To correlate the pH with swelling, we repeated Fischer's work on the action upon the lens of different acids and alkalies. The pH of each solution was determined by means of the glass electrode at the start of the experiment and at its conclusion. The results are reported in table 6.

It can be seen from this table that, de-

spite a marked absolute difference in the swelling of the lenses exposed to the same concentration of different acids, most acids had the same relative action at a particular pH value. The maximum swelling in every case except that of oxalic acid occurred in the pH range 1.25 to 2.90. The maximum values for lactic acid and for phosphoric acid could not be determined, since the lens capsule burst when they were placed in 1 N solution. The pH of 1 N lactic acid is 2.15 and for N phosphoric acid 1.45. In alkaline solution, the swelling became so marked that the lens capsule burst when the pH exceeded 11.65.

It was noted that in all solutions more dilute than 0.001 N, there was a marked change in the pH during the experiment with a final value of approximately 6.0 to 6.5. This change was probably due largely to the diffusion of salts from the lens. Thus the values obtained in 0.0001 N solutions and reported in table 6 as well as those appearing in Fischer's article are of little significance. The acid or base added originally becomes rapidly less effective because of the buffering effect of the lens.

Another complication in such swelling studies is the osmotic effect of the acid or alkali. We have already discussed the decreasing tendency of the lens to swell as the bathing medium becomes more hypertonic. It is unfair, for example, to compare the swelling in a 1-N solution against that of 0.01-N solution and to attribute any change therein to differences in acidity alone. Before the effect of the acidity itself can be evaluated, the osmotic effect due to the acid must be equalized.

To nullify such osmotic changes as well as to prevent the pH alterations during the progress of the experiment, we prepared a series of buffers in which the osmotic concentration at every pH was equal to that of 0.02-M nonelectrolyte solution.

TABLE 7

SWELLING OF LENS IN DIFFERENT BUFFERS

Buffer	pH	Swelling %	pH	Swelling %	pH	Swelling %	pH	Swelling %	pH	Swelling %
KH phthalate+HCl	2.80	9.49	3.00	7.26	3.35	7.65	3.75	9.68		
KH phthalate +NaOH	4.25	9.12	4.80	9.64	5.20	10.36	5.80	10.63	6.10	9.82
NaAc+HAc	3.85	14.18	4.20	17.14	4.75	13.14	5.10	10.72	5.80	9.16
KH_2PO_4+NaOH	6.20	10.26	6.75	11.21	7.00	10.01	7.60	10.43	7.80	11.21
NaOH+H_3BO_3	7.95	13.53	8.60	14.24	9.00	20.80	9.60	20.84	9.80	17.45

Unfortunately, the range of each buffer system employed was rather limited, compelling the preparation of several to cover the desired range. The swelling obtained after immersion in buffer solutions from pH 2.80 to 9.80 is presented in table 7.

The values secured indicate that even at the same pH and osmotic concentration there is a difference in swelling dependent upon the specific buffer employed. Using a phthalate-NaOH buffer system at pH 4.25, a swelling of 9.12 percent resulted. At the same pH with NaAc and acetic-acid buffer, there was 17.14-percent swelling. The swelling was greatest in the most alkaline range studied: 9.0 to 10.0, using NaOH-H_3BO_3 buffer.

In summary, then, there appears to be a marked effect on the swelling due to the hydrogen-ion concentration of the solution. At any hydrogen-ion concentration (or pH value), there will be a wide variation in the absolute swelling of the lens depending upon the specific acid or alkali employed. The relative swelling

with individual acids, however, seems to depend primarily upon the true acidity of the solution, so that the general shape of the curve with most acids is roughly the same. This is in accordance with the tendency of proteins to show a minimum swelling at the isoelectric point and maxima on both the acid and alkaline side of this point.[23] For most proteins, the maxima are at approximately pH 2.5 to 3.0 and about 10.5. These values of course will vary somewhat, depending upon the isoelectric point of the protein. For the proteins of the whole lens of cattle this point was found to be pH 5.16.[24]

We next investigated the effect of various organic compounds upon the swelling of the lens. The same procedure was followed that has already been described. Whenever feasible, solutions were prepared in 0.02 M concentrations to make the results comparable. Bellows and Rosner[25] reported a decreased permeability of the lens capsule when bathed by glucose or galactose solutions. Friedenwald's technique was employed by these workers. We could find no change from the normal uptake of water when the lenses were immersed in solutions of glucose, galactose, arabinose, xylose, or lactose. Nor could changes from normal be detected among a variety of other organic compounds. These included nicotinic acid, riboflavin, egg albumin, ergotamine tartrate, ascorbic acid, alloxan, phenol, ethyl alcohol, methyl alcohol, saponin, India ink, eosin, Congo red, and urethane. A few of the compounds examined showed significant decreases. These are reported in table 8. The percentage swelling resulting after two hours' immersion in the test solution was divided by the percentage swelling of the lens placed in vitreous of corresponding osmotic pressure for the same period. The decimal thus obtained affords an index of the relative inhibition of swelling by the test substances.

TABLE 8

ORGANIC COMPOUNDS CAUSING A DECREASED LENS SWELLING

Compound	Concentration	Index of Swelling $\left(\frac{\text{Percent swelling after treatment}}{\text{Percent swelling of control}}\right)$
Naphthol	<0.02 M*	0.83
Dinitrophenol	0.001 M	0.68
Dinitrophenol	0.005 M	0.66
Dinitrophenol	<0.02 M*	0.59
Acetone	0.002 M	0.79
Dinitrochlorobenzene	<0.01 M*	0.83
Acriflavin	0.0001 M	0.71
Acriflavin	0.001 M	0.56
Quinine sulfate	0.001 M	0.63

* Saturated solution.

Among the organic compounds possessing this property, several may have clinical implications. Production of cataract by dinitrophenol has been amply confirmed during the last few years,[26] but the cause of the opacity remains obscure. Borley and Tainter[27] investigated the effect of this compound on the permeability of the capsule, using Friedenwald's technique. They were unable to detect any change in the permeability. The effect of dinitrophenol on the swelling, however, was very striking. A saturated solution, which was somewhat less than 0.02 M, decreased the swelling by over 40 percent. Even with concentrations as low as 0.001 M significant in-

hibitions were obtained. Dinitrochlorobenzene, which is often found as an impurity in dinitrophenol samples, also produced a lowered swelling. This inhibition was less marked than with dinitrophenol.

The inhibiting effect of acetone in concentrations of 10 mg. percent (0.002 M) is interesting in view of the lens changes so often found in diabetic patients. The normal concentration of acetone in the blood is less than 1 mg. percent. In diabetes the concentration may rise as high as 300 mg. percent. The observation by Schanz[28] that acetone causes a sensitization of the lens protein also suggests a possible role of this compound in diabetic cataract.

Alpha naphthol, an oxidation product of naphthalene, was shown to have an inhibitory effect on lens swelling. Igersheimer and Ruben[29] found traces of this compound in the ocular fluids after naphthalene feeding. They found no cataractous action when alpha naphthol was given orally or intravenously. With beta naphthol, Pagenstecher[30] found lens changes comparable with similar quantities of naphthalene.

No change could be detected with urethane, a narcotic which has been shown to cause injury to sea-urchin eggs[31] with a consequent increase in permeability to water. Nor was any alteration in swelling noted when lenses were immersed in 0.1-percent egg-albumin solution. Friedenwald and Gifford and co-workers, using their respective techniques, had both detected a reduction in the capsular permeability with egg albumin. Friedenwald also reported a marked increase in permeability when the capsule was exposed to cataractous lens cortex. We noted no effect of cataractous lens substance on the lenticular swelling.

Since cataract may develop as a result of glaucoma, we thought it of interest to determine whether the swelling of the lens would be affected by an increased hydrostatic pressure. The lenses were placed in distilled water and the swelling determined after two hours at hydrostatic pressures varying from 5 to 100 mm. Hg. Furthermore, another group was covered with distilled water and the container evacuated to a total pressure of 20 mm. Hg. No difference could be detected in the degree of lens swelling at any of the pressures employed.

If alterations in the permeability of the capsule or in the water-binding properties of the lens do result after exposure to heightened hydrostatic pressures, they are too slight to be detected by our technique. It should be remembered, however, that our experiments were acute, lasting only several hours, whereas lens changes in glaucoma patients may not become manifest until rather late in the course of the disease.

The effect of the more common gases upon lenticular swelling was next determined. A fine, steady stream of the proper gas was bubbled for two hours through distilled water completely covering the lens under examination. The stream was directed away from the lens but the currents induced by the gas caused some bumping against the wall of the container. A stream of CO_2 caused a slight decrease, whereas H_2S, N_2, O_2, and H_2 all induced an increase when compared with the swelling of the lens immersed in distilled water alone. The swelling with O_2 was the most marked (table 9).

If the swelling in an inert gas (N_2) be taken as the standard, then CO_2 and H_2S both cause a decrease and O_2 an increase. The effect with CO_2 is much more striking than with H_2S. Hydrogen and N_2 gas have almost identical reactions. The difference between the swelling in distilled water and that with N_2 may be due to a traumatic effect of the con-

tusion against the wall. The variation in pH among these solutions was not great and could not account for the alterations in swelling. The significance of our findings is obscure but may be related indirectly to the cataract produced by general asphyxia,[32] or by local asphyxia resulting from the ligation of the ciliary arteries.[33]

Cellular injury is known to increase the permeability of the cell to water.[10]

TABLE 9

EFFECT OF GASES ON INDEX OF SWELLING

O_2	1.48	H_2S	1.09
H_2	1.27	H_2O	1.00
N_2	1.23	CO_2	0.89

This has been demonstrated for sea-urchin eggs,[34] artificial-muscle "cells,"[35] capillary walls,[36] muscle,[37] and other tissues. Hess[38] was the first to study histologically the changes following massage of the isolated lens of rabbits and calves. He found an increased permeability to water. Fluid accumulated most markedly under the anterior capsule, which then spread along the suture lines widely and deeply through the lens substance. Schirmer,[39] Demaria,[40] and Koppel[41] extended this work and noted variations with age, duration, and intensity of massage.

We produced lens injury by digital manipulation without tearing the capsule. By working the lens thoroughly between the fingers the lens substance could be softened considerably. The injured lenses took up almost twice as much water as did the controls (198 percent). This increase in water uptake following massage of the isolated lens agrees with the findings of Demaria[40] and of Hess.[38] The latter believed the primary change to be damage to the capsular epithelium. Busacca,[42] on the other hand, maintained that the pathology observed resulted from the toxic and osmotic effects of lenticular decomposition products. It seems unlikely that either explanation can account satisfactorily for the magnitude of the swelling we observed within a two-hour period. More probably the changes resulted from the physical effects of the treatment. Although the lenticular capsule remained unbroken in every case, the capsules of some individual fibers must undoubtedly have been disrupted by the massage. This would remove a corresponding number of barriers to the penetration of water while increasing the effective osmotic pressure. Of still greater importance would be a destruction of the normal contiguity of those fibers retaining intact capsules. Such destruction would expose a greater surface area of fiber to water. Furthermore, there is a far easier infiltration of water into the center of the lens through the interfibrillar spaces. The customary subcapsular accumulation of water with its consequent damming action is thus avoided.

The literature is replete with references to effects upon the lens of ultraviolet irradiation.[43] Normally, most of the rays are absorbed by the cornea when the whole eye is exposed, so that even after intensive irradiation with ultraviolet, macroscopic lenticular changes occur but rarely. Microscopically, degeneration of the capsular epithelium has been frequently observed.[38, 44] We investigated the swelling propensities of the lens when the intact eye was exposed to the action of ultraviolet rays. Beef eyes were exposed to a mercury-vapor lamp for periods up to two hours. The distance from the lamp to the cornea was 18 inches. At the end of this period, the lenses were removed, and the swelling tested in the usual manner. No difference from control lenses could be detected, either macroscopically or in the swelling tendency. These negative findings seem entirely explicable on the basis of the ultraviolet ab-

sorptive power of the cornea and aqueous humor.

Other lenses were freed from the eyeball and covered partially with water. Control lenses were similarly treated. The test lenses were then exposed to ultraviolet irradiation (18 inches from lamp) for two hours. The swelling for this period was only 83 percent that of the control (table 10). A tough, shrivelled, opaque layer formed at that portion of the lens exposed to the ultraviolet rays and not covered with water. No significant change in the ascorbic acid or glutathione contents of these lenses could be detected. Another group was completely immersed in vitreous humor, so that there was a layer 2 to 3 millimeters above the surface of the lens. After exposure to the ultraviolet rays for periods of 30 to 120 minutes, the lenses were placed in distilled water for two hours. An increased penetration of water occurred in the exposed lenses at every interval, with little difference between those exposed for 60 minutes and those for 120 minutes. The capsule seemed more fragile after exposure, so that after 120 minutes' exposure, it ruptured after the slightest manipulation. After 30 and 60 minutes' treatment, a similar but less marked fragility was noted.

In those lenses partially exposed to direct irradiation, the decreased water uptake can most easily be explained by a localized superficial coagulation of the lens proteins. The water-absorbing area was correspondingly diminished. On the other hand, those lenses completely immersed in vitreous showed a slight increase in swelling when exposed to the mercury-vapor lamp. The increased fragility noted in these lenses suggests that the changes of the capsule may be responsible for these findings.

The deleterious effects of X-rays[45] and radium[46] upon the lens have been known since the turn of the century. Weeks and even months must elapse before such manifestations become apparent. To test the effect of the roentgen irradiation, lenses were partially immersed in freshly filtered vitreous and then exposed to a total of 33,000 roentgens over a period of 33.5 minutes. A General Electric instrument was used with a 200-kilovolt peak and full wave rectification. Little change from the normal was evident. The water uptake was normal (table 10), and the glutathione and ascorbic-acid content was not decreased. Another batch of lenses was placed in a small beaker upon platinum vials containing a total of 129 mg. of radium. The lenses were completely covered with vitreous and allowed to remain in this condition for four hours, when they were removed and placed in water for two hours. No difference in swelling with respect to the control resulted either during the original four-hour period in vitreous, nor in the subsequent two-hour period in distilled water. The long latent periods before the effects appear clinically could explain our

TABLE 10

EFFECT OF IRRADIATION UPON SWELLING

Irradiation	Time	Swelling Index	Comments
Ultraviolet	30 min.	1.11	Completely immersed during exposure
	60 min.	1.19	Completely immersed during exposure
	120 min.	1.18	Completely immersed during exposure
	120 min.	0.83	Portion exposed to air during exposure
Roentgen ray	120 min.	1.03	Partially immersed
Radium	120 min.	0.96	Completely immersed

inability to procedure significant alterations.

That lightning may produce lens changes was observed by St. Yves in 1722.[47] Since then numerous cases of lightning cataract have been reported. Similar effects resulting from electric shock were first reported by Desbrieres and Bargy in 1905.[48] Hess[38] studied extensively the histologic variations following the experimental production of electric cataract in the rabbit. He found changes in the capsular epithelium within 15 to 30 minutes after sparking.

In an attempt to simulate these effects we exposed the whole eye to a high-voltage (15 to 20 kilovolts) current of low frequency (60 cycles) for short periods of time. The cornea was sparked for 1, 3, and 5 seconds and the sclera for 1, 3, 5, and 10 seconds. Longer sparkings caused a perforation of the eyeball, the sclera being more resistant than the cornea. Following this treatment, the lens was removed and the swelling measured. It was noted that the zonular attachment of the ciliary body to the lens became quite fragile so that the lens could be more easily removed than normally. This confirmed Hess's observations that the zonular fibers are loosened, with the lens separating more readily from the ciliary body. A typical Vossius ring was also deposited upon the lens. The capsule was more fragile and tore easily during dissection. As indicated in table 11, a marked decrease in swelling was effected even after exposures as short as one second. Sparking either the cornea or the sclera proved of approximately equal effectiveness. No change in the permeability of the capsule was evident when tested by Friedenwald's technique as modified by Bellows and Rosner.[25]

When a high voltage was produced, together with a high frequency, the marked changes described above were not seen. A voltage of approximately the same magnitude (10 to 15 kilovolts) was developed with a Victor variofrequency diathermy apparatus having a frequency of 750 kilocycles. After exposing the sclera to the spark for 10 seconds, the lens showed but a slight diminution in its

TABLE 11

EFFECT OF ELECTRICAL STIMULI UPON SWELLING

Current	Time	Swelling Index	Comments
A.C. 110 volts 60 cycles	45 seconds	0.94	
	60 seconds	0.99	
	120 seconds	0.79	
	300 seconds	0.73	
D.C. 110 volts	30 seconds	0.80	
	60 seconds	0.73	
	120 seconds	0.50	
	300 seconds	0.63	
A.C. low frequency 20,000 volts	1 seconds	0.54	Corneal exposure
	3 seconds	0.43	Corneal exposure
	5 seconds	0.46	Corneal exposure
	1 seconds	0.57	Scleral exposure
	3 seconds	0.41	Scleral exposure
	5 seconds	0.45	Scleral exposure
	10 seconds	0.41	Scleral exposure
A.C. high voltage high frequency	5 seconds	1.11	Corneal exposure
	10 seconds	1.07	Corneal exposure
	20 seconds	0.96	Corneal exposure
	10 seconds	0.87	Scleral exposure

swelling. This was far less than was obtained with the low-frequency current. Sparking the cornea resulted in little change of the lens.

In another experiment, fresh lenses were placed in Ringer's solution and a 110-volt, 60-cycle alternating current was passed through the solution for 45 to 300 seconds. Because of the heating effect, the lenses were subjected to the current for 15-second intervals until the desired time had been reached. The temperature at all times was maintained below 40°C. For the longer periods there was a decreased swelling, but in no instance was this diminution so marked as that obtained when the 110-volt direct current was passed through the solution for the same period of time.

The marked decrease in the swelling of the lenses exposed to high-voltage shock seems of significance in the pathogenesis of electric cataract. A full report of these findings and their relation to the various theories on the pathogenesis of electric cataract can be found in another publication.[49]

The greater effect of low-frequency over that of high-frequency current of similar voltage is probably explained by the Tesla or skin effects produced by the latter current. In this phenomenon, a high-frequency current tends to distribute itself upon the surface of a body rather than penetrating it. The higher the frequency, the wider is this distribution and the less the current passing through the body. The diminished effect upon the lens of high-frequency currents was thus probably due to a shunting of much of the current around the eyeball. Slight decreases of swelling were observed in these lenses indicating some effect.

The explanation for the greater effect of direct current upon the lens swelling is obscure. Possibly, it may be explained by the capacitance effect of the lens in the alternating current. Another factor that might account partially for the difference would be the greater tendency with direct current for ions to penetrate and to leave the lens.

Summary and Conclusions

1. Lenses were found to swell in accordance with the hypotonicity of the surrounding medium. The rate of the water uptake was determined in various dilutions of vitreous humor for periods of 2 to 360 minutes.

2. A method is given for the determination of the area of a lens surface. The rate of water diffusion into the lens was recalculated on the basis of the surface area.

3. Approximately a straight-line relationship was found between the weight and surface area of adult beef lenses.

4. No consistent permeability constant (k) could be obtained for the lens. K represents the cubic millimeters of water passing through each square centimeter of membrane per minute per atmosphere difference in osmotic pressure. Probable causes of this variability are discussed.

5. The water uptake of calf lenses was found to be approximately double that of the cattle lenses examined for the same length of time.

6. A slight but consistent increased swelling was noted with a rise in temperature from 16 to 46°C. At 6°C. a greater swelling was observed than at much higher temperatures. The significance of this finding in relation to cold cataract is discussed.

7. The effects of a number of inorganic compounds were tested. With cations the greatest swelling was found with Sn^{++++} followed in descending order by Sn^{++}, Al^{+++}, Cd^{++}, Fe^{+++}, K^{+}, Fe^{++}, Li^{+}, Co^{++}, NH_4^{+}, Th^{++++}, Na^{+}, Tl^{+}, Mn^{++}, Mg^{++}, Ba^{++}, Cu^{++}, Ni^{++}, Sr^{++}, Ca^{++}, and Hg^{++}. With the anions, cyanide solutions in-

duced the greatest swelling followed by oxalate, SCN^-, I^-, SO_4^{--}, Br^-, Cl^-, NO_3^-, F^-, and citrate following in that order. When the same cation of different valences was employed, the greater swelling occurred with the higher-valence ion. The swelling activity of the halogen ions varied directly with their molecular weight.

8. Despite marked absolute differences, the swelling with different acids had the same relative action at a particular pH value. Maximal swelling occurred at pH 1.25 to 2.90 and in solutions more alkaline than 11.65. Unbuffered solutions more dilute than 0.001 N suffered great changes in pH during the experiment. Various buffered systems may affect swelling differently even when the hydrogen-ion concentrations and osmotic strength are identical.

9. Acriflavine, quinine sulfate, dinitrophenol, acetone, dinitrochlorobenzene, and alpha naphthol cause decreased swelling in the order named. A large number of important physiological compounds were tested with negative results.

10. Changes in hydrostatic pressure from $^+740$ to $^-100$ mm. Hg (atmospheric pressure) produces no change in the water uptake of the lens.

11. CO_2 and H_2S caused a decreased swelling (compared with H_2 and N_2 taken as standards). When O_2 was bubbled through the solution, a significant increase resulted.

12. Following injury from massage, the lens absorbed almost twice as much water as the control.

13. Lenses from intact eyes exposed to ultraviolet irradiation showed no change; completely immersed isolated lenses an increase, and partially uncovered lenses a decrease in swelling when compared with their respective controls. No alteration of ascorbic acid or glutathione content of the lens following exposure was detected. Neither X-ray nor radium produced any alteration in the swelling.

14. The swelling of lenses from eyes subjected to exposure of a high-voltage (15 to 20 kilovolts), low-frequency (60 cycles) current for 1 to 10 seconds was greatly decreased. With high-frequency current of similar voltage, only a slight decrease in swelling was produced. Passage of 110-volt direct current through a solution containing the lenses caused greater inhibition of swelling than 110-volt alternating current.

15. The significance of these findings is discussed in relation to various types of experimental and clinical cataract.

We wish gratefully to acknowledge the aid and advice given us so generously by C. J. Farmer, H. B. Bull, S. L. Osborne, J. H. Cilley, and J. Boutwell.

Bibliography

[1] Kunde, F. Ueber Wasserentziehung und Bildung vorübergehender Katarakte. Zeit. f. Wissensch. Zool., 1857, v. 8, p. 466. (Cited by Deutschmann[2].)

[2] Deutschmann, R. Untersuchungen zur Pathogenese der Katarakte Arch. f. Ophth., 1877, v. 23, p. 112.

[3] Manca and Ovio. Recherches sur la cataract experimentale specialement en point de vue des propriétés diosmotiques de la lentille cristalline. Arch. ital. de Biol., Pisa, 1898, v. 29. (Cited by Fischer[5].)

———. Etudes sur la cataracte expérimentale experiences sur la cataracte naphthalinique. Ibid., 1900, v. 34.

[4] Römer, P. Die Pathogenese der Cataracta senilis vom Standpunkt der Serumforschung. 3. Die physiologischen Schwankungen des osmotischen Druckes der intraoculären Flüssigkeit in ihren Beziehungen zum osmotischen Druck des Blutserums. Arch. f. Augenh., 1907, v. 56, Ergänzh. 150.

[5] Fischer, F. P. Wasserbindung, Durchsichtigkeit, and Durchlässigkeit der Linse. Arch. f. Augenh., 1933, v. 108, p. 80.

[6] Leber, T. Zirkulation und Ernährung. Graefe-Saemisch Handbuch der gesamten Augenheilkunde, 2te Aufl., 1900.
[7] Wessely, K. Der Flüssigkeits- und Stoffwechsel des Auges mit besonderer Berücksichtigung seiner Beziehungen zu allgemein-physiologischen und biologischen Fragen. Ergebn. Physiol., 1905, v. 4, p. 565.
[8] (a) Friedenwald, J. S. Permeability of the lens capsule, with special reference to the etiology of senile cataract. Arch. of Ophth., 1930, v. 3, p. 182.
(b) ———. Permeability of the lens capsule to water, dextrose, and other sugars. Ibid., 1930, v. 4, p. 350.
[9] Gifford, S. R., Lebensohn, J. E., and Puntenny, I. S. The biochemistry of the lens: I. Permeability of the capsule of the lens. Arch. of Ophth., 1932, v. 8, p. 414.
[10] Lucké, B., and McCutcheon, M. The living cell as an osmotic system. Physiol. Rev., 1932, v. 12, p. 68.
[11] Lucké, B., Hartline, H. K., and McCutcheon, M. Further studies on the kinetics of osmosis in living cells. Jour. Gen. Physiol., 1931, v. 14, p. 405.
[12] Löwenstein, A. Eine neue Anschauung über die Entstehung des Altersstars. Arch. f. Ophth., 1926, v. 116, p. 438.
[13] Krause, A. C. The biochemistry of the eye. Baltimore, Md., The Johns Hopkins Press, 1934.
[14] (a) Northrop, J. H. Kinetics of the swelling of cells and tissues. Jour. Gen. Physiol., 1927, v. 11, p. 43.
(b) Delf, E. M. Studies of protoplasmic permeability by measurement of the rate of shrinkage of turgid tissues: I. The influence of temperature on the permeability of protoplasm to water. Ann. Botany, 1916, v. 30, p. 283.
[15] McCutcheon, M., and Lucké, B. The kinetics of osmotic swelling in living cells. Jour. Gen. Physiol., 1926, v. 9, p. 697.
———. The kinetics of exosmosis of water from living cells. Ibid., 1927, v. 10, p. 659.
[16] Jacobs, M. H. The permeability of the erythrocyte. Ergebn. d. Biol., 1931, v. 7, p. 1.
[17] ———. Osmotic properties of the erythrocyte: I. Introduction. A simple method for studying the rate of hemolysis. Biol. Bull., 1930, v. 58, p. 104.
[18] Fauré-Fremiet, E. L'oeuf de Sabellaria alveolata L. Arch. d'Anat. Microsc., 1924, v. 20, p. 212.
[19] Jess, A. Beiträge zur Kenntnis der Chemie der normalen und der pathologischen veränderten Linse des Auges. Zeit. f. Biol., 1913, v. 61, p. 92.
[20] Loeb, J. The organism as a whole, from a physicochemical viewpoint. New York, G. P. Putnam's Sons, 1916.
[21] Buschke, A. Demonstration von Mäusekatarakten nach Verfütterung von Thallium. Zeit. f. Augenh., 1922, v. 48, p. 302.
———, and Löwenstein, L., and Joel, W. Weitere histologische Befunde bei experimenteller chronischer Thallium Vergiftung. Klin. Woch., 1928, v. 7, p. 1515.
Ginsberg, S., and Buschke, A. Ueber die Augenveränderung bei Ratten nach Thallium Fütterung (Katarakt und Iritis) und ihre Beziehung zum endokrinen System. Klin. M. f. Augenh., 1923, v. 71, p. 385.
[22] Hofmeister, F. Zur Lehre von der Wirkung der Salze. Arch. f. exper. Path. u. Pharmakol., 1888, v. 24, p. 246.
[23] Gortner, R. A. Outlines of biochemistry. New York, John Wiley and Sons, Inc., 1938.
[24] O'Brien, C. S., and Salit, P. W. Isoelectric point of lens proteins. Arch. of Ophth., 1931, v. 6, p. 870.
[25] Bellows, J., and Rosner, L. Biochemistry of the lens: XI. Effect of galactose on permeability of the capsule of the lens. Arch. of Ophth., 1938, v. 20, p. 80.
[26] Boardman, W. W. Rapidly developing cataract after dinitrophenol. Jour. Amer. Med. Assoc., 1935, v. 105, p. 108.
Horner, W. D., Jones, R. B., and Boardman, W. W. Cataracts following the use of dinitrophenol. Preliminary report of 3 cases. Jour. Amer. Med. Assoc., 1935, v. 105, p. 108.
Lindberg, J. G. Eight cases of dinitrophenol cataract, two of them with punctuated, stationary opalescences of the lens of a type not hitherto described. Acta Ophth., 1938, v. 16, p. 556.
[27] Borley, W. E., and Tainter, M. L. Effects of dinitrophenol on the permeability of the capsule of the lens. Arch. of Ophth., 1937, v. 18, p. 908.
[28] Schanz, F. Die Wirkung des Lichtes auf die lebenden Organismen. Biochem. Zeit., 1915, v. 71, p. 406.
[29] Igersheimer, J., and Ruben, L. Zur Morphologie und Pathogenese der Naphthalinveränderung im Auge. Arch. f. Ophth., 1910, v. 74, p. 467.

[30] Pagenstrecher, E. Experimentelle Untersuchungen über die Entstehung angeborener Anomalien und Missbildungen im Säugetierauge. Munch. Med. Woch., 1914, v. 61, pt. 1, p. 583.

[31] Lucké, B. The effect of certain narcotics (urethanes) on permeability of living cells to water. Biol. Bull., 1931, v. 60, p. 72.

[32] Biozzi, G. Augenveränderungen durch Asphyxie. Die experimentelle asphyktische Katarake. Arch. f. Ophth., 1935, v. 133, p. 423.

[33] Wagenmann, A. Experimentelle Untersuchungen über den Einfluss der Circulation in den Netzhaut- und Aderhautgefässen auf die Ernährung des Auges, insbesondere der Retina, und über die Folgen der Sehnervendurchschneidung. Arch. f. Ophth., 1890, v. 36, pt. 4, p. 1.

[34] Lucké, B., and McCutcheon, M. The effect of injury on cellular permeability to water. Arch. Path., 1930, v. 10, p. 662.

[35] Winterstein, H. Beiträge zur Kenntnis der Narkose. IV. Mitteilung: Narkose und Permeabilität. Biochem. Zeit., 1916, v. 75, p. 71.

[36] Landis, E. M. Microinjection studies of capillary permeability I. Factors in the production of capillary stasis. Amer. Jour. Physiol., 1927, v. 81, p. 124.

[37] Loeb, J. The physiological effects of ions I. Decennial Publ., Univ. Chicago, Chicago, 1905, v. 2, p. 450.

[38] Hess, C. Pathologie und Therapie des Linsensystems. Graefe-Saemisch Handbuch der gesamten Augenheilkunde, 1911, pt. 2, ch. 9.

[39] Schirmer, O. Experimentelle Studie über die Forster'sche Maturation der Katarakten. Arch. f. Ophth., 1888, v. 34, pt. 1, p. 131.

[40] Demaria, E. B. Experimentelle Untersuchungen über die Erzeugung von Katarakt durch Massage der Linse. Arch. f. Ophth., 1904, v. 59, p. 568.

[41] Koppel. Cited by v. Szily, A., "Linse." In Lubarsch, O., and Henke F.: Handbuch der speziellen pathologischen Anatomie und Histologie. Berlin, Julius Springer, 1937, p. 170.

[42] Busacca, A. Boll. Ocul., 1926, v. 5, p. 70. Cited by v. Szily, p. 190. (See preceding reference.)

[43] Duke-Elder, W. S. The pathological action of light upon the eye. Lancet, London, 1936, v. 2, pp. 1157, 1168, 1250.

Birch-Hirschfeld, A. Die Wirkung der ultravioletten Strahlen auf das Auge. Arch. f. Ophth., 1904, v. 58, p. 469.

———. Die Veränderungen im vorderen Abschnitt des Auges nach häufiger Bestrahlung mit kurzwelligem Lichte. Ibid., 1909, v. 71, p. 573.

———. Zur Beurteilung der Schädigungen des Auges durch leuchtende und ultraviolett Strahlen. Klin. M. f. Augenh., 1909, v. 47, pt. 2, p. 26.

———. Zur Beurteilung der Schädigung des Auges durch kurzwelliges Licht. Zeit. f. Augenh., 1909, v. 21, p. 385.

[44] Duke-Elder, W. S., and Duke-Elder, P. M. A histological study on the action of short-waved light upon the eye, with a note on inclusion bodies. Brit. Jour. Ophth., 1929, v. 13, p. 1.

[45] Chalupecky. Ueber die Wirkung der Roentgenstrahlen. Centralbl. f. Augenh., 1897, v. 21, p. 386.

Guttman. Starbildung durch Röntgenstrahlung. Sitzgsber. Heidelberg, 1905, p. 337.

Treutler. Starbildung durch Röntgenstrahlen. Ibid., 1905, p. 338.

Paton, L. A case of posterior cataract commencing subsequent to prolonged exposure to X-rays. Trans. Ophth. Soc. United Kingdom, 1909, v. 29, p. 37.

Axenfeld, T., Küpferle, L., and Wiedersheim, O. Glioma retinae und intraokuläre Strahlentherapie. Klin. M. f. Augenh., 1915, v. 54, p. 61.

Birch-Hirschfeld, A. Die Wirkung der Röntgen- und Radiumstrahlen auf das Auge. Arch. f. Ophth., 1904, v. 59, p. 229.

Axenfeld, T. Doppleseitiges Glioma retinae und intraokuläre Strahlentherapie. Klin. M. f. Augenh., 1914, v. 52, p. 426.

Wilkinson, O. Cataract probably due to X-ray exposure. Amer. Jour. Ophth., 1904, v. 3, p. 435.

Rohrschneider, W. Klinischer Beitrag zur Entstehung und Morphologie der Roentgenstrahlenkatarakt. Klin. M. f. Augenh., 1928, v. 81, p. 254.

[46] Meesmann, A. Beitrag zur Röntgen-Radiumstrahlenschädigung der menschlichen Linse. Ibid., 1928, v. 81, p. 259.

Martin, P. The effects of irradiation of the eye by radium. Trans. Ophth. Soc. United Kingdom, 1933, v. 53, p. 246.

[47] St. Yves. Les causes accidentelles, qui peuvent blesser la vue. Nouv. Traité de Mal des Yeux, 1722, p. 368. Cited by v. Szily (see reference 41).

[8] Desbrieres and Bargy. Un cas de cataracte due à une décharge électrique industrielle. Ann. d'Ocul., 1905, v. 133, p. 118.

[9] Bellows, J. G., and Chinn, H. The biochemistry of the lens XIV. Studies on electric cataract. Arch. of Ophth., 1941, in press.

Discussion

Dr. Jonas S. Friedenwald (Baltimore): I should like to ask a few questions in relation to some of the phenomena that Dr. Bellows has reported without explanation.

In respect to the effect of various gases on the swelling of the lens, has it occurred to him that those gases which had a depressing effect on the swelling of the lens were the gases which make ions in solution and that, therefore, the tonicity of his solution when he bubbled hydrogen sulfide or carbon dioxide through the solution was considerably higher than when he bubbled hydrogen or nitrogen?

In the second place, he pointed out the fact that in regard to those ions which exist in two valence forms, the one that has the higher valence has the greater effect.

When an ion exists in two valence forms, the one that has the higher valence is an oxidizing substance, and I should like to know whether this effect could be correlated with oxidation, in view of the fact that the lens protein has very readily oxidizable side chains.

Dr. Bellows: Dr. Friedenwald's point is well taken as to higher tonicity causing a lowered swelling. The gases that produce the decrease, such as hydrogen sulfide and carbon dioxide, would have greater osmotic powers than the others due to their solubility in the medium. This would certainly tend to lower the swelling of the lens. I doubt whether the ionic concentration would be appreciably affected, since both hydrogen sulfide and carbonic acid are weakly dissociated. We were unable to detect any change in pH during the bubbling, indicating that little dissociation had taken place.

The decreased swelling with hydrogen sulfide might be largely accounted for on the basis suggested by Dr. Friedenwald, since this was rather slight. I think it improbable, however, that the marked decrease in swelling with carbon dioxide can be explained to any great extent as a purely osmotic phenomenon. A saturated solution of carbon dioxide would be equivalent to only about 0.03 M solution, whereas to produce a comparable decrease in swelling, a considerably higher osmotic force would be necessary.

As far as oxidation of the protein and higher valence is concerned, that is a fact I did not consider at all. Perhaps Dr. Chinn could answer that.

Dr. Chinn: The increased oxidizing power of the higher valence compound might somehow account for a slightly greater swelling of the lens. It is doubtful, however, that this effect could be very marked. The oxidizing tendency of a system is related to its electrode potential (E_o). The higher the potential the more oxidizing the system. Magnesium has an E_o of $^{+}1.87$, quite a high value, while the E_o of tin is only $^{+}0.14$. Nevertheless, the swelling of the lens in stannous-chloride solution is almost three times that in a magnesium-chloride solution of the same molarity. In general, no correlation could be obtained between lens swelling and the oxidizing ability of the solution. Nor did an increased valence necessarily produce an increased swelling. Thus, the chloride of tetravalent thorium ($ThCl_4$) showed a much lower swelling than did the chloride of univalent potassium (KCl) or lithium (LiCl).

OCULOGYRIC CRISES*

A THERAPEUTIC APPROACH

ROLAND M. KLEMME, M.D.
Saint Louis

Of all the unfortunate human beings who are afflicted with postencephalitic residuals, those suffering with oculogyric crises are perhaps among the most pitiable. Since Hohman[1] in 1925 first reported this syndrome in this country, reports of several hundred such cases have appeared in the literature. Most writers on the subject are in agreement that these attacks are the later results of epidemic encephalitis. Jelliffe,[2] however, states, "Oculogyric crises *per se* are not phenomena present only in postencephalitic patients." He states that they may be observed in patients with neurosyphilis, brain tumor, multiple sclerosis, hysterical attacks, arteriosclerotic Parkinsonism, and numerous psychic states. Nevertheless, reports are difficult to find in which the basis is some other disease than encephalitis. The history of this interesting association between encephalitic and postencephalitic states has been well reviewed in the article by Jelliffe[3] and more recently by Weiner.[4]

INCIDENCE

This condition is apparently becoming more common or it is being more frequently recognized. Shortly after the world-wide epidemic of 1920, the incidence, according to Jelliffe,[3] ranged from 3 to 5 percent. Hall[5] in 1931 reported a morbidity of 15 to 20 percent in his group of 384 postencephalitic Parkinsonians. Weiner[4] in 1940 reported an incidence of 43.6 percent in his group of 55 cases. We have encountered but 3 such cases in a group of over 200 dystonias.

*From the neurosurgical service of Roland M. Klemme, Chairman, Division of Neurosurgery, St. Louis University.

MECHANISM OF PRODUCTION

The mechanism of production of oculogyric crises is unknown. As is usual in instances in which little knowledge is available, there is a multitude of theories. In the few cases in which careful autopsies have been performed[6] in patients known to have suffered with oculogyric crises, the central-nervous-system findings were those of the classical postencephalitic type; that is, there was a gliosis of the corpus striatum, the substantia nigra, and their connecting tracts. The most voluminous writings on this subject have been offered by Jelliffe,[2, 3] who has studied postencephalitic cases most extensively. He is joined by Wexberg[7] in his views that oculogyric crises are compulsion phenomena with a "somatic substratum." More definite localization is not contained in the writings of these authors. Muskens[8] has placed the lesion in the mesencephalon between the neo, and paleo-striatum in the region of the posterior commissure. Hall[5] makes no attempt to locate the lesion centrally, but relates oculogyric crises to the phenomena of sleep. McCowan and Cook[9] in 1928 proposed a loss of cortical inhibition as the causal mechanism. No effort is made in this present paper to enter the controversy as to the etiology and pathology of this condition.

TREATMENT

Most of the case reports examined hold no brief for any type of therapy. The favorite drugs used have been members of the hyoscine group. Weiner[4] used stramonium, benzedrine sulfate, hyoscine, and atropine sulfate singly and in various combinations in a group of 24 patients,

with varying degrees of success. He came to the conclusion that stramonium in combination with Benzedrine sulfate was most effective. Ziskind and Sommerfeld[10] used metrazol (convulsion) therapy with some benefit in two cases. Leake[11] treated one case with prominal, and states what we believe is probably the usual attitude toward therapy in postencephalitic disorders. "For if it does nothing else it tends to make the patient more comfortable, or at least less aware of his miseries."

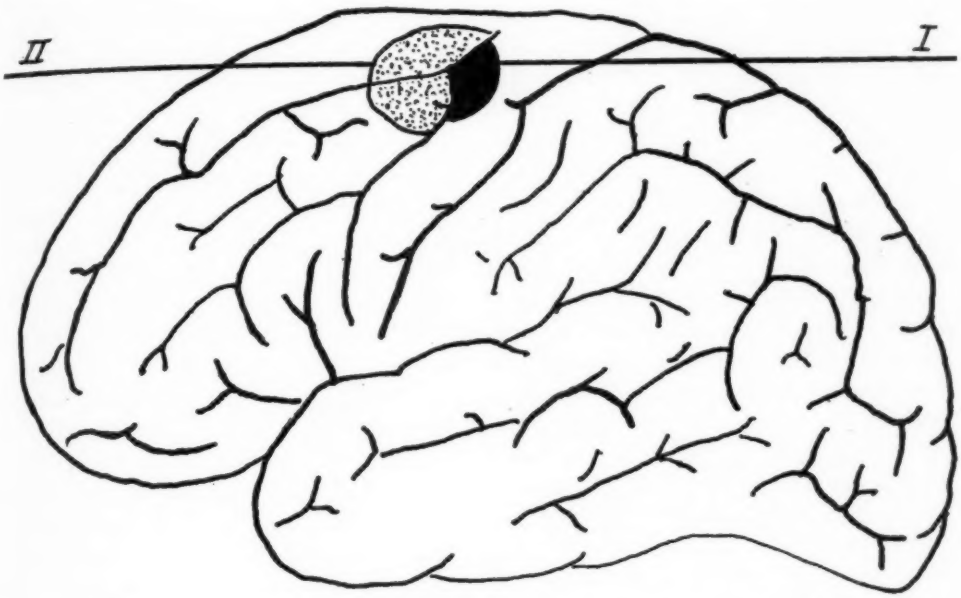


Fig. 1 (Klemme). Area I (dark area) stimulated to induce oculogyric crises. Area II (dotted area) premotor center removed to depth of sulcus.

Work on Parkinson's disease and athetosis

In 1937 I first began to perform the operation of premotor cortical excision[12] upon this unfortunate group of people which I designate the dystonias. This latter term is taken from Kinnier Wilson and means variability in muscle tone. The group includes, for the most part, paralysis agitans and athetosis. That I should use his terminology is, I believe, entirely fitting as it was from his suggestion, made in 1912,[13] namely, that the premotor or frontal areas are the cortical mirrors of the lower or striatal centers, that I first conceived the operation of premotor cortical removal in an attempt to do something for this group of patients. I was further attracted to this view by the extremely important work by John Fulton[14] and his group, in studying the function of the premotor cortex in the higher apes. Since the year 1937, I have excised the premotor cortex in more than 130 patients.

Operative procedure

A frontal flap is turned in the usual manner with the skin flap over the corresponding eye and the bone flap over the ear. The dura is opened with base toward the longitudinal sinus. The size of the flap varies, depending upon the extent of the involvement of the patient, clinically. For instance, a patient with athetoid

movements involving only the right arm will need but a small left frontal flap. When the cortex is thus exposed, the anterior edge of the motor cortex is carefully outlined by Faradic stimulation in the region of the desired center. Using the electro-surgical knife, the premotor area, anterior to the center of the region involved, is then excised to the depth of a sulcus (fig. 1). The wound is closed with silk throughout in the usual manner. The results of these excisions are to be published in another report. A preliminary report was published in 1937.

During the course of these operations, many interesting phenomena were noted. I first became acquainted with the disparity of the actual physiologic reaction caused by stimulation of the motor cortex and that mapped out by the various textbooks on anatomy. Furthermore, I noted the great differences in mapping out the motor centers of humans as compared to those of the higher apes. These latter observations have too often been assumed as true for the species *Homo sapiens* as well. I agree with Scarff[15] that there are gross differences. The experience of outlining the motor cortex in more than 130 cases with cortical stimulation will likewise be reported subsequently.

In the meantime, three patients with a history of oculogyric crises were operated upon with the object in mind of alleviating their suffering from paralysis agitans. Much to my surprise the oculogyric spasms ceased postoperatively, and the patients were quite as delighted with their result as with the improvement in their other symptoms.

Following this a little further, I began isolating the cortical center of the eye movements at each succeeding operation. I found that, with a little care, practically typical oculogyric attacks could be produced by cortical faradic stimulation at the junction of the first and second frontal convolutions, adjacent to the anterior edge of the motor cortex. This was done in the next 85 patients operated upon, and with identical results.

In February, 1940, the operation of premotor cortical excision was first performed for the express purpose of relieving oculogyric crises.

Case report

G. O., a woman aged 30 years, referred by Drs. A. E. Bennett and L. T. Hall of Omaha, Nebraska, was admitted to St. Luke's Hospital on November 6, 1939, with a chief complaint of spasms of the eyes of nine years' duration. In 1924 the patient had developed sleeping sickness and was ill for about three weeks. Her physician performed a lumbar puncture and made a diagnosis of sleeping sickness. She received encephalitis serum on nine occasions and had numerous reactions. The patient left the hospital at about Thanksgiving time in 1924, and was well until 1930. During this time, she noticed that her speech was slowed and monotonous. In 1930 she began to have attacks of spasm of the ocular muscles, during which her eyes would roll upward and to the right. The attacks increased in frequency during the nine years before her entry to St. Luke's Hospital, until she was having them about every three days. Her only relief from these attacks was obtained by falling asleep. She had had slight difficulty in using her left upper extremity during the year prior to admission.

Neurological examination was negative, with the exception of a horizontal nystagmus with the greatest swing to the right, and a slight weakness in the grip of the left hand. The physical examination disclosed nothing remarkable. An encephalogram was done on November 10, 1939, which showed a normal ventricular system.

The patient was allowed to go home, but returned to St. Luke's Hospital in February, 1940. On February 26, 1940, a right premotor cortical excision was performed. The motor cortex was carefully outlined, and the upward spasmodic movements of the eyes were reproduced by faradic stimulation. A small area of premotor cortex was removed anterior to this center. The patient had an uneventful postoperative recovery. A careful study of the entire visual mechanism of this patient was done preoperatively and postoperatively by Dr. J. H. Judd of Omaha. His findings were as follows:

First examination, preoperative, April 15, 1937. Vision, R.E. 20/200—1; L.E. 20/200. With correction vision could be improved to R.E. 20/20—1; L.E. 20/20—1. Visual fields were normal, and the blind spots were within normal limits.

The patient was given a series of orthoptic exercises in the hope that by increasing her amplitude of fusion she might regain better muscular control. Muscle balance for distance showed 1 degree of esophoria, no hyperphoria; for near she had an exophoria of 18 degrees and no hyperphoria. Her adduction was 24, abduction 8. External examination, including ocular movements, pupillary reactions, and intraocular tension, was normal. Ophthalmoscopic examination revealed clear media, with normal discs and fundi.

Second examination, preoperative, August 10, 1939. The muscular condition was essentially the same. There had been some increase in her compound myopic astigmatism so that new correction was necessary. Her vision at that time, with correction, was R.E. 20/20—1, L.E. 20/22—1.

Third examination, postoperative. Uncorrected vision R.E. 20/133, L.E. 20/160. With her old glasses R.E. 20/150, L.E. 20/50. *With a change in correction both eyes improved to 20/20.* Her pupils were contracted to 2 mm., and reacted sluggishly to light and in accommodation. Conjugate movements were full and normal, and the intraocular tension was normal. Ophthalmoscopic examination showed each disc to have blurred margins, but no elevation. The muscle balance for distance showed 1 degree of exophoria; for near 17 degrees of exophoria. Adduction was 17, abduction 10. Near point was R.E. 31 cm., L.E. 29 cm., showing a subnormal accommodation. The disc margins regained their normal appearance after a short time. With the use of one drop of 1-percent pilocarpine, three times a day, there was a steady improvement in accommodation, so that her near point on July 23, 1940, was R.E. 14, L.E. 12 cm. The patient was able to read much better at this time.

These findings were corroborated by those of Dr. H. R. Hildreth of Saint Louis, who also examined the patient postoperatively.

Fourth examination, August 23, 1940. Vision with correction was normal. The muscle-balance tests continued to indicate the same amount of exophoria for near, signifying a marked weakness of convergence, as is often found in cases of subnormal accommodation.

These examinations show a slight but definite improvement in the objective tests of vision and muscle tone of the eyes. *Since operation, on February 26, 1940, this patient has had no recurrence of her oculogyric crises.*

Comment

A case report has been presented concerning a patient exhibiting oculogyric crises. Chemotherapy is merely palliative and very discouraging in the opinion of all the authors who have written upon this subject. As far as can be determined by a search of the literature, the case herein described offers the first satisfac-

tory result of any type of therapy in oculogyric crises. Surgical intervention by excisions of premotor cortex at the junction of the first and second frontal convolutions adjacent to the anterior edge of the motor cortex, is the operation here reported. Justification for this procedure is based upon a series of more than 130 cases of premotor cortical excision for treatment of the allied conditions, paralysis agitans and athetosis. A similar procedure has been successful in four patients, three with an associated Parkinson's syndrome, and the one here reported with a pure oculogyric-crises syndrome.

Conclusion

Operative interference with removal of premotor cortex at the junction of the first and second frontal convolutions adjacent to the anterior edge of the motor cortex is the treatment of choice in patients with oculogyric crises.

4952 Maryland Avenue.

Bibliography

[1] Hohman, L. B. Forced conjugate upward movements of the eyes in post-encephalitic Parkinson's syndrome. Jour. Amer. Med. Assoc., 1925, v. 84, p. 489.

[2] Jelliffe, S. E. Psychology of forced movements in oculogyric crises. New York, Nervous and Mental Disease Publishing Company, 1932.

[3] ———. Psychologic components in post-encephalitis oculogyric crises. Contribution to genetic interpretation of compulsion phenomena. Arch. Neurol. and Psychiat., 1929, v. 21, p. 491.

[4] Weiner, H. I. Treatment of post-encephalitics—especially oculogyric crises. Illinois Med. Jour., 1940, v. 77, p. 141.

[5] Hall, A. J. Chronic epidemic encephalitis with special reference to ocular attacks. Schorstein Memorial Lecture. Brit. Med. Jour., 1931, v. 2, Nov., p. 833.

[6] Marinesco, G., and Draganesco, S. Pathogenesis of oculogyric crises in post-encephalitic Parkinsonism—two cases. Rev. d'Oto-Neurol.-Opht., 1932, v. 10, p. 396.

[7] Wexberg, E. Psychopathology of oculogyric crises. Jour. Neurol. and Ment. Dis., 1937, v. 85, p. 56.

[8] Muskens, L. J. Pathology of post-encephalitic disturbances in light of recent anatomical and physiological research. Jour. Neurol. and Psych., 1927, v. 8, p. 132.

[9] McCowan, P. K., and Cook, L. C. Oculogyric crises in chronic epidemic encephalitis. Brain, 1928, v. 51, p. 285.

[10] Ziskind, E., and Sommerfeld-Ziskind, E. Metrazol therapy (convulsions) in chronic encephalitis with Parkinsonism; effect on oculogyric crises. Bull. Los Angeles Neurol. Soc., 1938, v. 3, p. 186.

[11] Leake, W. M. Treatment of oculogyric crises. Brit. Med. Jour., 1935, v. 2, Dec. 14th, p. 1153.

[12] Klemme, R. M. Athetosis, surgical treatment: preliminary report of four cases—three unilateral and one bilateral. Southern Med. Jour., 1938, v. 31, p. 1095.

[13] Wilson, S. K. Progressive lenticular degeneration. A familiar nervous disease associated with cirrhosis of the liver. Lancet, London, 1912, v. 1, pp. 1115-1119.

[14] Fulton, J. F. Forced grasping and groping in relation to the syndrome of the premotor area. Arch. Neurol. and Psychiat., 1934, v. 31, pp. 221-235.

[15] Scarff, J. E. Primary cortical centers for movements of upper and lower limbs in man. Observations based on electrical stimulations. Arch. Neurol. and Psych., 1940, v. 44, p. 243.

HYPEROSTOSIS OF THE ORBIT*

WILLIAM L. BENEDICT, M.D.
Rochester, Minnesota

Major malformations or deformities of the bones of the skull or the face are for the most part congenital or secondary to a metabolic disturbance of which the bony changes are only a part of a widespread syndrome. Minor changes, however, are not often evident on inspection but are revealed by roentgenography. The significance of minor areas of hyperostosis as revealed by the roentgenogram is realized particularly in the diagnosis of certain intracranial tumors such as meningioma, in cases of exophthalmos of obscure origin, and in chronic inflammatory diseases about the inner aspect of the frontal bone, the greater wings of the sphenoid and the sella, and in the paranasal sinuses. Some degenerative changes in the bones about the orbit also are followed by thickening of bone. Softening and degeneration of bone are characteristic of Hand-Schüller-Christian syndrome, chloroma, epidermoids, and some rare forms of neoplastic disease of the contiguous tissues. The disease may be arrested or altered by irradiation or surgical intervention so as to bring about healing processes. In such cases, the newformed bone usually becomes more dense than the immediately surrounding uninvolved bone and may appear in the roentgenogram as hyperostosis.

Pathologic thickenings in the bony walls arise from injury and disease of the bone as well as from proliferations of bone tissue or its periosteum consequent to developmental abnormalities. It is not always possible to make a clear clinical distinction between inflammatory disease and malignant disease of the bone. Periostitis of the orbit due to syphilis or tuberculosis is characterized by a firm, rounded mass on the orbital rim that increases in size rather rapidly to several millimeters of thickness within a few weeks. There is an accompanying swelling of the adjacent soft tissues with congestion of the skin and subcutaneous tissues. The region of the swelling is somewhat tender to palpation. In syphilis, the upper orbital rim is most frequently involved; in tuberculosis the lower temporal region is the seat of predilection. Bony lesions due to systemic infections, particularly syphilis and tuberculosis, usually run a brief course, resolving under appropriate treatment or breaking down through central necrosis into soft masses that drain spontaneously through fistula formation or become quiescent through encapsulation and caseation. Other signs of the general infection may be elicited through laboratory tests and physical examination. In all cases of suspected disease of the orbital walls, roentgenograms of the head and biologic tests of the blood serum for syphilis must be made.

Aside from the affections of the anterior segment of the orbit, differentiation between inflammatory or other benign thickenings and tumors either is not difficult or is not so essential, since surgical procedures are indicated for only a few of the conditions that may result from bone formation. Roentgenograms of the orbit will show the extent to which the bone is involved, but will give little other information that cannot be inferred from inspection and palpation of the involved region in cases of inflammatory swelling.

*From the Section on Ophthalmology, The Mayo Clinic. Read before the first Pan-American Congress of Ophthalmology, Cleveland, Ohio, October 11 and 12, 1940.

The great value of roentgenographic examination lies in the differentiation of inflammatory, benign and malignant swellings in doubtful cases, such as may be encountered in an individual in whom signs of a malignant neoplasm or of inflammation are manifest. In the middle and posterior regions of the orbit stereoscopic roentgenography is of the greatest value, for it frequently gives the only definite signs of the nature of the disease. Lateral displacement of the eyeball, exophthalmos, disturbances of motility of the globe, changes in the vision and visual fields, and pathologic alterations in the fundus may be present in some form and to some degree from a number of different causes. For differential diagnosis they provide very little help.

Bony tumors of the orbit are significant from the standpoint of their surgical removal, and as the surgical risk increases in proportion to the size of the tumor and the extent to which neighboring structures are involved, early diagnosis is desirable.

Situated in the wall of the orbit, they extend into the region of the nasal accessory sinuses, the cranium, and the bones of the face, as well as into the orbit, and they not infrequently involve a consideration of the probabilities of a fatal issue from their encroachment on the brain. The ophthalmologist is particularly interested in them because of the displacement of the eye and disturbances of vision. The rhinologist and the neurosurgeon are also frequently interested in them because of the necessity of operation for the relief of symptoms in their respective fields.

Pathologic thickenings in the bony walls of the orbit arise from the bones of which the orbit is formed or from the paranasal sinuses. It is not always possible to make a clear clinical distinction between inflammatory and malignant disease of the bone and the benign spontaneous enlargements or growths that spring from the sinuses or the hyperplastic expansion such as frequently occurs in the frontal bone and the maxilla. A history of injury to the face or head followed by bony changes in a few months or years may be obtained in almost every case, for such minor injuries are common.

Bony tumors of the orbit are divided, on the basis of their origin, into two large groups: osteomas, tumors arising from the nasal sinuses and extending into the orbit; exostoses and hyperostoses, tumors arising from the surface of a bone as nodules or projections or diffuse thickening and hypertrophy of the bone in response to irritation from contiguous pathologic processes.

Osteoma

From a clinical standpoint it is advisable to give the name osteoma not to all the bony tumors of the orbit, as is frequently done, but only to the encapsulated bony outgrowths of the sinuses, which involve the orbit secondarily. They are not to be aligned with thickening of the orbital wall developing on the basis of inflammatory stimuli (periostitis ossificans), nor is it a question of a hypertrophy of the mass of the orbital wall, of leontiasis ossea of Virchow.

They probably do not arise from the process of repair of injury but develop from congenital disturbances of development and displacement of cartilage and residues, in addition to which there is a direct eburnation due to subperiosteal deposits of concentric bone lamellae and the formation of medullary spaces.

The ethmoid, frontal, and sphenoid sinuses give rise to osteomas in the order of frequency named. The situation of an osteoma may be indicated by the changes it brings about in the contour of the face, the position of the globe, and disturbance of the ocular motility. Stereoscopic roent-

genographs, however, allow very accurate localization and visualization of the displacement of the sinuses. As osteomas are very slow in developing, a history of the onset and course of the symptoms aids in differentiating them from other firm nonbony tumors with which they may be confused.

The growth, which extends over years, advances particularly during and after puberty, that is, in the period when the sinuses attain greater size. The same thing occurs during growth at the epiphyses of the long bones. But no part of the skeleton is more predisposed to osseous hypergenesis than is the orbit, because of the intimate connections which exist between the numerous bones that form it—frontal, maxilla, lacrimal, os planum, sphenoid, and palatine—and the reciprocal troubles that can so easily occur in their development.

Origin of osteomas

While there is hardly any portion of the walls of the orbit from which an osteoma cannot arise, the incidence in reported cases favors the superior and nasal walls, showing that the greater number of orbital osteomas arise from the ethmoid cells and the frontal sinuses. The region of the lacrimal process in the maxilla and of the lacrimal bone gives rise to tumors that extend into the orbit and the nasal cavity. Only those tumors that arise about the anterior portion of the orbit or that lie near enough to the rim of the orbit to be felt by the fingers give early signs of their presence, and by the development of symptoms allow an early diagnosis. A mass the size of a split pea about the region of the lacrimal groove or on the margin of the orbit would be detected before any displacement of the globe could be effected, but in the deeper portions of the orbit, particularly posterior to the equator of the globe, a tumor larger than the eyeball may work its way into the orbit before sufficient sign of its invasion calls attention to its presence.

There is, however, not the uniformity of direction of growth that is necessary to make it possible to determine the point of origin of an osteoma by the direction of lateral displacement of the globe or by the amount of proptosis. A tumor of the os planum may extend laterally across the roof of the orbit as a roll of bone behind the superior rim and the lateral portion may expand so as to push the globe straight forward or even somewhat to the nasal side. In many reported cases surgeons were unable to determine from which sinus the tumor took its origin, as during its development it spread to the region of neighboring bones, becoming interlocked in a series of hard nodules and mucus-containing cells with bands of intervening fibrous tissue.

From the viewpoint of surgical complications, it would seem desirable to discuss osteomas in regard to their point of origin and to divide them into tumors of the ethmoid, frontal, sphenoid, and maxillary sinuses. From any one of the bones containing these sinuses osteomas may invade the orbit or the cranial cavity. There is a direct connection with the nasal cavities along the mucous membrane of the sinus that forms the covering of the osteoma about which infection may travel. This probably accounts for the relatively large postoperative mortality of pioneer surgery in this field and the various surgical methods devised to obviate it. The situation of the tumor in cases in which operation has been performed at the Mayo Clinic is shown in table 1. The removal of osteomas of the orbit is usually a major procedure, and the method of operation, of course, depends on the structures involved. Some of them may be removed by direct approach through the

orbital outlet, a few through the nose. They should not be approached transcranially because they lie extradurally and in a potentially infected field. I have discussed elsewhere operative methods that have been found applicable in cases of osteoma situated in the anterior part of the orbit.[1]

TABLE 1
OSTEOMA OF THE ORBIT

Location	Age, years						Total	
	10–19	20–29	30–39	40–49	50–59	60–69	Number	Percent
Frontal	3	3	3	3	1		13	38.2
Sphenoid*	2	1		3	2	1	9	26.5
Ethmoids	3	1					4	11.8
Temporal			1	2		1	4	11.8
Maxilla		1			1		2	5.9
Antrum					1		1	2.9
Nasal		1					1	2.9
Total	8	7	4	8	5	2	34	
Percent	23.5	20.6	11.8	23.5	14.7	5.9		100

* In one case the lesion was recurrent. Youngest patient aged 10 years (girl). Oldest patients aged 60 years (man and woman). Average age, 35.3 years. Seventeen men, or 50 percent of cases. Seventeen women, or 50 percent of cases.

Exostosis

The small projections of bone that spring from the margin of the orbit are known as exostoses. They come about as a result of chronic inflammation in the soft tissues. They are seldom seen within the orbit and have no surgical significance. New formation of bone tissues which protrudes as patches or bands at the internal aspects of the cranial bones causes irritation or compression of the brain with consequent circulatory disturbances in the prefrontal and frontal lobes and at the base of the brain. Patients with this disease, known as Morgagni's endocraniosis, suffer sometimes from intractable frontal headaches, apathy, asthenia, and psychic depression. Some patients suffer from diabetes insipidus, disorders of sleep, psychic changes, irritability, neurasthenia and, in some instances, dementia. Other patients suffer progressive blindness or deafness, loss of the sense of smell, and epileptiform and involuntary sudden muscular contraction. Infection of the sinuses may spread intracranially to the internal aspects of certain cranial bones and to the dura mater, with consequent thickening of the involved bones. The process may originate also in disturbances of the bones or of the dura mater. In all cases hypophyseal and neurohypophyseal disorders may coexist.

Hyperostosis

About the deeper structures of the orbit, particularly the roof of the orbit and the optic canal, thickenings of the bony walls are brought about by a variety of pathologic conditions, most of which originate in the adjacent soft tissues. In the frontal bone and the orbital plate of the frontal bone benign osteomas may give rise to a widespread diffuse thickening of true bone without involving the contiguous soft tissues. Such osteomas are not encapsulated. They are not sharply circumscribed and consist of superimposed layers of eburnated bone or of cancellous bone with cystic spaces covered by a thin eburnated shell. Over the large wing of the sphenoid and particularly

along the sphenoid ridge, thickening of the bone is very frequently brought about by meningioma. These tumors, which originate in the arachnoid, spread along the surface of the cranial vault, finally penetrate the bone, and enter the orbit, where they produce exophthalmos, paralysis of the ocular muscles, and even loss of sight. A meningioma may arise along the sheath of the optic nerve and bring about calcification in the apex of the orbit, causing constriction of the optic canal and diffuse thickening of the bone in the region of the sella. The same bony changes, however, that are found in the roof of the orbit as a result of meningioma are also found as a result of tumors within the orbit which involve the periorbita.

Hyperostosis of the walls of the orbit has been found to result from hemangioendothelioma, dermoid cyst, hemangioma with arteriovenous aneurysm, endothelioma of the brain, anomalous development of the sphenoid ridge, squamous-cell epithelioma of the nasopharynx, Mikulicz's disease, arteriovenous aneurysm in the brain, meningioma of the sphenoid ridge, and neurofibroma of the orbit. The symptoms associated with these pathologic changes include migraine, petit and grand mal, headaches, exophthalmos, disturbances of ocular motility, various changes in the visual fields, and diminution of visual acuity.

Hyperostosis of bones of the posterior part of the orbit and the roof of the orbit is only evident by roentgenogram. The lesion usually is diffuse, without sharply defined margins. Dense shadows representing contiguous tumors of the soft tissues may be detected. The significant features in the roentgenogram have to do with the situation of the shadow, whether the lesions seem to be multiple or single, whether they are sharply bordered or have soft margins, the extent to which the cranial bones seem to be involved, and the extent of protrusion of the lesion into the cranial cavity or into the orbit.

Report of cases

Case 1. Benign frontal hyperostosis.—The patient, a girl, aged 18 years, had no ocular symptoms. The roentgenogram of the head showed benign frontal hyperostosis with anomalous development of the sphenoid ridge on the right side.

Case 2. Localized osteitis deformans involving the orbit.—The patient was a man, aged 36 years. His chief complaint was headaches. Vision was 6/6 in both eyes. The fields and fundi were normal. A roentgenogram of the skull showed a large hyperostosis involving the frontal bone and encroaching on the superior wall of the left orbit, which was approximately a fourth smaller than the right one. The diagnosis was localized osteitis deformans, of the leontiasis ossea type. Operation was not performed.

Case 3. Frontal osteoma.—The patient was a woman, aged 29 years. Her chief complaint was a feeling of pressure about the left superior orbital arch and the left side of the nose, lightheadedness, giddiness, and nausea. Vision was 6/6 in both eyes. The fundi and fields were normal. Ocular movements were not impaired. A roentgenogram showed hyperostosis of the left frontal region. Meningioma was suspected and seemed to be corroborated by the roentgenogram. At operation an osteoma of the left side of the frontal bone was found which measured about 8 by 5 by 3 cm. The osteoma, including the entire thickness of the skull, was removed. Meningioma was not found. The dura was opened and reflected. The brain was found to be perfectly normal. The pathologic diagnosis was osteoma of the left frontoparietal region.

Case 4. Fibro-osteoma of frontal sinuses.—The patient was a man, aged 42 years. During general examination, the roentgenogram of the sinuses revealed a large osteoma of the frontal sinuses particularly on the right, involving the anterior ethmoids. The inner table of the skull was not involved. Operation was performed and most of the tumor removed. The pathologic diagnosis was fibro-osteoma.

Case 5. Hemangioma with thrombi.—The patient was a girl, aged 19 years. Her chief complaint was right exophthalmos. A roentgenogram of the orbit showed a small rounded area of calcification lying within the right orbit near the lateral margin. The diagnosis was hemangioma (venous aneurysm). A right transfrontal craniotomy with an exploration of the orbit through removal of the roof was done. A cavernous hemangioma containing many thrombi was found partly within and partly without the orbit. The involved bone was thickened.

Case 6. Hemangioma with increased density of sphenoid ridge and exophthalmos.—The patient was a woman, aged 25 years. Her chief complaint was left exophthalmos. Tumor of the left orbit was suspected. Ophthalmoscopic examination showed benign melanoma of the choroid in the left eye. A roentgenogram of the head showed a soft-tissue tumor in the left orbit. The left optic canal was larger than the right and appeared to be somewhat eroded. There was a slightly increased density of the sphenoid ridge on the left side. A transcranial operation revealed hemangioma in the retro-orbital region.

Case 7. Hyperostosis of the left sphenoid ridge, exophthalmos, Mikulicz's disease of the orbit and meningioma.—The patient was a woman, aged 25 years. At the age of 23 years she had first noticed occasional swelling of her left upper eyelid associated with slight discoloration. The swelling would last for two or three days and disappear. Four months previous to her first visit to the clinic, her left eye protruded and had not receded. The vision in each eye without glasses was 6/10. The left eyelid was swollen and prominent but not paralyzed. The left eyeball was depressed about 4 mm. The exophthalmometer readings were: right 21, left 27 mm. Roentgenograms showed normal optic canals and bony thickening of the frontal bone on the left side with some apparent involvement of the lateral margin of the greater wing of the sphenoid. Because of increasing exophthalmos, an exploration of the orbit was made on December 31, 1938. Along the lateral wall of the orbit, situated mostly below the lacrimal fossa and extending toward the inferior orbital fissure, was a firm nonencapsulated tumor approximately 1 by 3 cm. The tumor was removed by blunt dissection. There were no dehiscences in the walls of the orbit and not much bleeding in the orbital tissues. The tumor was entirely removed. The pathologic diagnosis of tissues removed was Mikulicz's disease. The proptosis receded and the patient was dismissed on January 5, 1939. The vision was 6/12.

She returned on March 6, 1940, because of recurrence of proptosis of the left eye. There was no pain about the orbit and only a slight swelling of the lid. With glasses, vision of the right eye was 6/5; of the left, 6/30. The exophthalmometer readings were: right 20, left 33 mm. A roentgenogram of the skull showed a large left frontal and basofrontal meningioma with osteomatous thickening of the floor of the left anterior fossa and also of the anterior and lateral aspects of the frontal bone on the left side. On March 9th, a left transfrontal craniotomy was performed and multiple meningiomas were found. The pathologic report showed diffuse inflammatory reaction with many lymphocytes. The wound was closed with a celluloid plate and opened two weeks later. Tissue removed at this time was diagnosed as inflammatory. The clinical diagnosis was basofrontal meningioma. The pathologic diagnosis of tissue removed from the orbit was Mikulicz's disease; from the brain, inflammatory tissue. It is quite likely that the same process was involved throughout.

The patient returned for observation August 5, 1940. Vision of the right eye was 6/5, of the left eye 6/20. The right eye was in normal position, the left eye depressed 5 mm. The exophthalmometer reading was right eye 21, left eye 21 mm. There was no sign of recurrence of the tumor of the orbit. Diplopia was present owing to paralysis of the left-superior-rectus and the left-lateral-rectus muscles. The patient's general condition was otherwise entirely satisfactory.

Case 8. Frontal osteoma with failing vision, optic atrophy, meningioma, with psammoma bodies.—The patient was a woman, aged 37 years. Her chief complaint was failing vision. She could perceive only moving objects with her right eye and only light with her left eye. The visual field of the right eye was limited to the 35-degree isopter in the lower-nasal quadrant. Ophthalmoscopic examination of the right eye revealed pallor grade 2, on a basis of 1 to 4, of the nasal portion of the disc, and pallor grade 4 of the temporal portion with loss of substance of the nerve head. The left eye showed pallor of the disc grade 4 with simple optic atrophy. A roentgenogram revealed extensive destruction of the sella, the lesser wing of the sphenoid in the region of the sella, and the cribriform plate. There was also a destructive process involving the frontal bone on the left side above the frontal sinus. The entire process had the appearance of a malignant neoplasm. Bilateral frontal craniotomy was done with removal of the osteoma. The osteoma in the frontal region was due to a meningioma that had penetrated the bone and was attached to the overlying scalp. There was a huge mass of tumor tissue that extended both ways from the midline and was densely adherent to the posterior wall of the frontal sinuses. The diagnosis was meningioma with psammoma bodies.

Case 9. Osteoma of left side of sphenoid, loss of vision in left eye, exophthalmos, meningioma.—The patient was a woman, aged 38 years. Her chief complaint was loss of vision in the left eye. The duration of symptoms was nine months. Her vision was right eye 6/5 and left eye ability to count fingers at 4 feet. The exophthalmometer reading was right eye 19, left 23 mm. Ophthalmoscopic examination of the left eye showed slight pallor of the temporal portion of the disc, with only a suggestion of loss of nerve substance. A roentgenogram revealed a dense osteoma involving the greater wing of the sphenoid on the left, probably due to meningioma. At operation, there was no evidence of

meningioma pressing on the optic nerve. The dura was then stripped up from the orbit down over the edge of the lesser wing of the sphenoid without encountering a tumor. The posterior two thirds of the left orbit was unroofed, but no tumor was encountered in the orbit. A flat sessile type of meningioma which had arisen from the floor of the middle fossa and extended upward toward the lesser wing of the sphenoid lacked at least 1 cm. of reaching the lesser wing of the sphenoid and was more than 1 cm. from the optic foramen and left optic nerve. The loss of vision was due to encroachment on the nerve by osteoma.

Case 10. Osteoma of lesser right wing of sphenoid, meningioma extending into the orbit and causing blindness.—The patient was a woman, aged 59 years. Her chief complaints were failing vision of the right eye for three and a half years, blindness for past six months, and paralysis of the right-external-rectus muscle for three and a half years. Her vision was right eye nil, left eye 6/6. Exophthalmometer readings were right eye 19.5, left 17.5 mm. Ophthalmoscopic examination showed pallor grade 3 of the temporal portion of the right disc, and pallor grade 1 of the nasal portion of the right disc with simple optic atrophy; the left disc was normal with a deep physiologic cup. A roentgenogram showed osteoma with thickening of the lesser wing of the sphenoid on the right and involvement of the right anterior clinoid. The diagnosis was meningioma of the right sphenoid ridge with extension into the right orbit.

Case 11. Osteoma of right side of sphenoid, meningioma, extending into the orbit, producing exophthalmos; visual acuity normal.—The patient was a man, aged 56 years. His chief complaint was right exophthalmos. Vision was 6/6 in each eye. The right eye was 8 mm. lower than the left. Exophthalmometer readings were right 27, left 19 mm. Rotation of the eyes was good except that the right eye could not be elevated. A roentgenogram showed a dense osteoma involving the wing of the sphenoid on the right side extending laterally to the frontosphenoid and sphenoidotemporal junction. Changes were secondary to a large contiguous meningioma. At operation, the osteoma was found to be very hard; it had extended into the orbit and surrounded the optic canal. It was not possible to remove the portion of the bone that was producing exophthalmos without risk of injuring the optic nerve.

Case 12. Osteoma of the right side of sphenoid with exophthalmos; normal visual acuity and visual field.—The patient was a man, aged 46 years. His chief complaint was exophthalmos of the right eye. The visual fields showed an enlargement of the blind spot on the right and depression of the right-superior quadrant. Vision was 6/6 in each eye. Exophthalmometer readings were right 24, left 16 mm. There was no diplopia nor limitation of ocular movements. A mass could not be felt in the right orbit. Visual fields were normal. Ophthalmoscopic examination showed 3 diopters of papilledema in the right eye. A roentgenogram showed a well-defined osteoma of the wing of the sphenoid on the right side secondary to a large meningioma. There was an osteomatous thickening extending into the orbit. The right side of the frontal bone was considerably increased in vascularity. The patient had an extensive osteoma of the dorsal orbital plate and the right posterior angle of the frontal and temporal bones. The osteoma was about 2 cm. in thickness and it had caused some enlargement in the temporal fossa but produced its greatest damage by growing into the superior fossa and right orbit. The size of the tumor was 7 by 9 by 1.5 cm.

Comment

The group of bony tumors classified as hyperostosis comprises the greater number of pathologic bony changes about the orbit. They may be distinguished from the osteomas of the sinuses by the difference in the sharpness of the shadow shown in the roentgenogram and by the contour and situation of the lesion. However, hyperostosis of the roof of the orbit that is secondary to meningioma is difficult to distinguish from the hyperostosis due to arteriovenous aneurysm, hemangioma with thrombosis, endothelioma, and some other neoplasms of the contiguous soft tissues.

While the removal of osteomas that penetrate the orbit from the paranasal sinuses may be accomplished by a frontal approach through the orbital outlet, meningiomas should never be removed through this route. Hyperostosis occurring in the roof of the orbit without involvement of the frontal bone or extension into the ethmoid or sphenoid should always arouse a suspicion of meningioma and be approached only by the transcranial route.

Vascular tumors of the orbit that are accompanied by hyperostosis have probably extended through the orbital wall into the cranial cavity. This may not al-

ways be so. However, it is almost impossible to remove a large diffuse hemangioma through the orbital outlet. By a transcranial approach and removal of the roof of the orbit, it may be possible to remove the tumor entirely without injury to the optic nerve. The choice of method of operation must be determined in each case by the facts presented.

Reference

[1] Benedict, W. L. Bony tumors of the orbit. Ohio State Med. Jour., 1925, v. 21, Aug., pp. 557-561.

Discussion

Dr. A. D. Ruedemann, Cleveland: Dr. Benedict's excellent paper leaves very little for one to discuss. He has covered the subject of bony changes around the orbit completely and thoroughly.

As most changes around the orbit must be diagnosed by exclusion, it is in the bony changes that one has an excellent aid in the use of the roentgen ray. Attention must be called to the fact that roentgenograms must be taken in stereo and the opposite orbit be taken for contrast. If there is any doubt regarding the optic canals, bilateral orbital roentgenograms should be taken in order to get the comparison of size. Changes around the orbit may or may not reduce the size of the orbit itself—when they do, it produces an exophthalmos that may necessitate surgery. However, many of these cases do not produce exophthalmos because the involvement is posterior in the orbital wall and may diminish the size of the optic canal and by direct pressure on the optic nerve produce optic atrophy.

Some of these patients have a relatively rapid loss of vision, and this requires rather early intervention. Besides the X-ray study, it may be necessary to invoke the aid of a neuro-surgeon as well as a nasorhinologist.

Dr. Benedict mentions the results of trauma on the orbit. In most cases of trauma of the orbit, an exophthalmos is induced by means of a secondary atrophy to the orbital tract. However, as pointed out in Dr. Benedict's paper and as can be seen on the slide, some of these patients have a displacement of the nasal bone which will produce globe displacement and which may simulate encroachment of a bony tumor on the orbit.

Osteoma of the orbit, which may be secondary to previous nasal inflammation, should be removed by the route that gives the best functional result. However, most of them can be removed by the anterior route, by reflection of a muscle if necessary, and one may maintain integrity of the orbit throughout.

Hyperostosis and exostosis produce an entirely different story. Here, we must remove part of the bony wall of the orbit, usually in an area that is complicated by other important structures, such as internal carotids, cavernous sinus, and optic nerves, and it frequently happens that the surgical procedure is too complicated to maintain normal orbital relationship subsequent to surgery. However, in many of these instances, the orbital involvement is only secondary to involvement of the skull and this may be too extensive for complete removal. Local surgery may be only palliative insofar as the eyeball is concerned.

It is surprising how little pain most of these patients with orbital bony changes do have, and it is because of this that so few of them come for consultation early enough. Usually, when they are first seen by an oculist, they have such extensive

changes that it requires almost complete destruction of the orbital wall entirely to remove the growth.

The sphenoidal-ridge meningiomata, because of their location, may induce changes simulating pituitary tumors, but one must remember that most of these are unilateral, the optic nerve itself looking like that seen in pituitary-tumor cases. It is better to group these as lesions in the region of the chiasm. Complete removal of the meningioma is not unusual, but rather difficult and must be done early in order to get the best results; later removal is almost impossible because of the involvement of too many important structures, and by this time the optic nerve is completely atrophic. A great deal can be done, however, in relieving optic-nerve and orbital embarrassment, and these patients may continue for a long period of time without much difficulty. The case at point is a patient who, over a period of some 10 years, has carried on with an endothelioma involving the temporal bone and the orbit and who, in the course of her surgery, had to have an eyeball removed because of the almost complete proptosis.

Rather extensive osteomatous changes may be removed successfully. I recall a case of nasochiasmal osteoma, removed by the late R. Bishop Canfield, in which both eyeballs had been so badly displaced that the patient could count fingers posterior to one ear. The total amount of tumor mass removed was equal to the size of a tennis ball. The man had very little optic atrophy subsequent to his surgery and recovered good use of his eyes although over a long period of time he did have an annoying diplopia. A case similar to this is shown on the slide and it might be well to remember that a great deal can be done to the orbit with retention of good useful vision.

There is a curse to the statement "temporal pallor within normal limits" unless this statement is followed out by visual-field studies to rule out the possibility of a field loss. Unless one is constantly on the lookout for these patients, they may slip by for a long period of time and, although the seriousness of the loss of sight is extremely important, even more important is the fact that these patients may go on beyond the realm of good surgical removal. This is especially true of the sphenoidal-ridge tumors that produce an early optic-nerve change—sometimes a late exophthalmos if any at all.

As most of these lesions involve intracranial structures, it is important to have on hand a neurological surgeon who can aid in the diagnosis and, in most instances, do the surgery. The operations, as you all know, are long drawn out and painstaking and, if you are in association with a neurosurgeon, a good functional result can be obtained by being on hand to help with any necessary procedure. It is my opinion that wherever the orbit itself is involved the ophthalmic surgeon should enter into the field of surgery whenever the orbit is entered.

As outlined by Dr. Benedict, early differential diagnosis is important, but even more important is surgery if it is done early enough for the patient to get the best functional result both as to his general health and the local eye condition.

HEREDITARY CRANIOFACIAL DYSOSTOSIS*

ELMER A. VORISEK, M.D.
Chicago

In 1912, Crouzon[1] described a form of osseous dystrophy characterized by (1) a cranial deformity; (2) facial malformation; (3) ocular changes; and (4) heredity. To this entity he gave the name of "Hereditary dysostosis craniofacialis." Briefly, the cranial deformity is a type of brachycephaly, with hypoplasia of the superior maxilla, and prognathism of the lower jaw. The ocular findings are a marked proptosis or severe exophthalmos, with hyperteloric eyes, associated with marked divergence, choked disc, optic neuritis, and secondary optic atrophy. There may be mental deficiency; heredity is frequently reported; and most of the cases have occurred in persons of French extraction.

It is thought that in fetal development the lower part of the skull fails to develop while the brain grows normally, thus spreading out the pliable portions of the cranial vault, and resulting in increased intracranial pressure producing digitations in the thinning cranial plates and followed by choked disc.

Atkinson[2] in 1936, reviewing all the cases reported since 1912, said that 86 were certain cases, whereas 8 were uncertain. In 5 cases the divergence was not mentioned, nystagmus was described in only 6 cases, and in 28, or 33 percent, of the cases no mention was made of heredity nor the existence of the disease in any other member of the family. Curiously enough, no report of this anomaly had been made in the English language prior to 1936.

Since previous authors have discussed this deformity in more or less detail, the present discussion will be limited to the presentation of two cases that have been under our observation at the Children's Memorial Hospital.

Case 1. R. P., male of German and Scotch-Irish ancestry, was first seen when less than two years of age, in April, 1935, by Dr. R. C. Gamble. Two sisters and both parents were living and well; they had a normal appearance, and there was no history of a hereditary tendency. At that time the following typical physical findings were noted: The nose was broad and flat. The head was rather high, but otherwise appeared normal. The anterior fontanelle was about 1 cm. in diameter, and the cranial sutures were well marked, but thicker than normal. Externally, the eyes were very prominent and widely separated, but appeared of normal size. Ocular rotation was good in all directions; both corneae were clear; the edges of each disc were indistinct; and the retinal veins were a little tortuous. The dentition appeared normal, but there was a marked prognathism of the lower jaw, with an undeveloped superior maxilla.

Roentgenographs of the skull showed a thinning of the skull tables, with marked pacchionian depressions of the entire skull. The sagittal suture was not closed, whereas the cranial suture existed only near the fontanelle. The floor of the sella was depressed and apparently the sphenoid was not pneumatized. The vertical diameter of the skull was enlarged out of proportion to the anteroposterior diameter, but the head did not have the typical turret shape. All this suggested marked intracranial pressure.

By January, 1936, the patient was be-

* From the Clinics of the Children's Memorial Hospital. Read before the Chicago Ophthalmological Society, October 21, 1940.

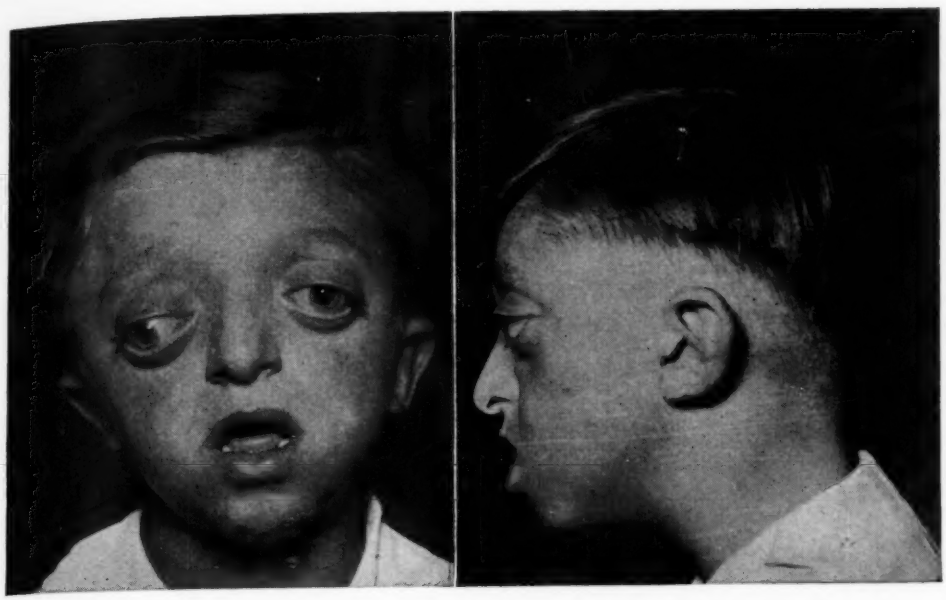


Fig. 1 (Vorisek). R. P. (see case 1), seven years of age; note decompression bulge over right temporal region.

coming more difficult to manage at home. The eyes became much more prominent, excessively proptosed, and a marked hypertelorism and divergence developed with very limited outward rotation. The pupils reacted briskly, and the subjective vision appeared to be quite good, although choked discs were present. After consultation, Drs. Joseph Brennemann and R. C. Gamble recommended that both a cranial and orbital decompression be performed. The child was consequently referred to Dr. Paul Bucy of the Billings Hospital, where, early in 1936, at the age of 2½ years, a decompression of the right orbit and of the right subtemporal region was performed. Shortly after this, the case was reported by Buchanan and Krause[3] who have also been following the progress of this boy; their article ends with the following statement: "In spite of operative decompression of the cranium and right orbit there is no reason to believe the prognosis will be favorable for either the eye, mentality, or life."

This boy continues to be a patient at the Children's Memorial Hospital 4½ years after the decompression operations. He is at present seven years of age (figs.

Fig. 2 (Vorisek). R. P. Roentgenograph taken at five years of age from right side, showing bony decompression defect and digitations.

1, 2), and because of the great interest aroused, this case is again being reported to include the subsequent postoperative course.

Following the decompressions the right eye showed an extreme proptosis with a corneal ulcer from exposure, while the left eye showed only marked proptosis. There was no marked edema nor atrophy of either disc, and the decompression was soft. Mentally the patient appeared to be very much improved. By February, 1937, the discs had assumed a more normal appearance, but the proptosis remained about the same. By December, 1937, a considerable improvement was noted in the degree of proptosis, with both the right and left upper lids now covering their respective eyeballs. Both discs continued to appear normal.

In January, 1938, a psychometric examination report stated: "The first impression seemed to indicate low mentality. . . . His appearance and speech are very deceiving, but his mental ability is normal with an I.Q. of 100."

Although a marked divergence of the right eye still existed, the ocular movements were normal and full in all directions except as to the upward movement of the right eye. There was a faint corneal scar in the right pupillary area. In March, 1939, the vision was recorded as R. 20/200, L. 20/20, and skiascopic examination under atropine revealed a slight myopia in the right eye and a slight hyperopia in the left eye; but since there was no improvement of vision in either eye with a correction, and since there were present no subjective visual symptoms, no glasses were ordered.

Fig. 3 (Vorisek). C. G. (see case 2) at seven months of age.

At present the patient is able to attend regular school and is doing very well. He displays normal intelligence, and there are no neurological findings. The subtemporal decompression is soft and the discs show

neither atrophy nor edema.

One week after the decompression in February, 1936, Buchanan reported the exophthalmometer findings, with the instrument spread to 99 mm., as R. 33 mm., L. 26 mm. In October, 1940, we found the exophthalmometer reading, also at 99 mm., as R. 28 mm., L. 25 mm., and the distance between the two internal canthi was 37 mm.

A roentgenographic report in April, 1940, stated: "Views of the skull now show marked increase in the digitations over that noted in the earlier films"; in September, 1940, "Good views of the optic foramina show that they are symmetrical in contour and equal in size. There is a slight decrease in the penetration of the soft tissues of the right orbit as compared with the left."

Case 2. C. G., a male, of Polish ancestry (normal delivery, full term baby) was the only child. Both parents were living and well, and no evidence of hereditary factor was present. The child was first seen at the age of seven months when he was brought in, not because of illness, but because the parents were concerned regarding the shape of the head (fig. 3). He had a peculiar contour of the skull. There was a rounded bulging protrusion of the whole anterior portion of the head. The fontanelles were about 1 cm. wide. The eyes were prominent with slight divergence. The pupillary distance was 62 mm. There was slight swelling of both optic discs, and the vision was apparently still quite good.

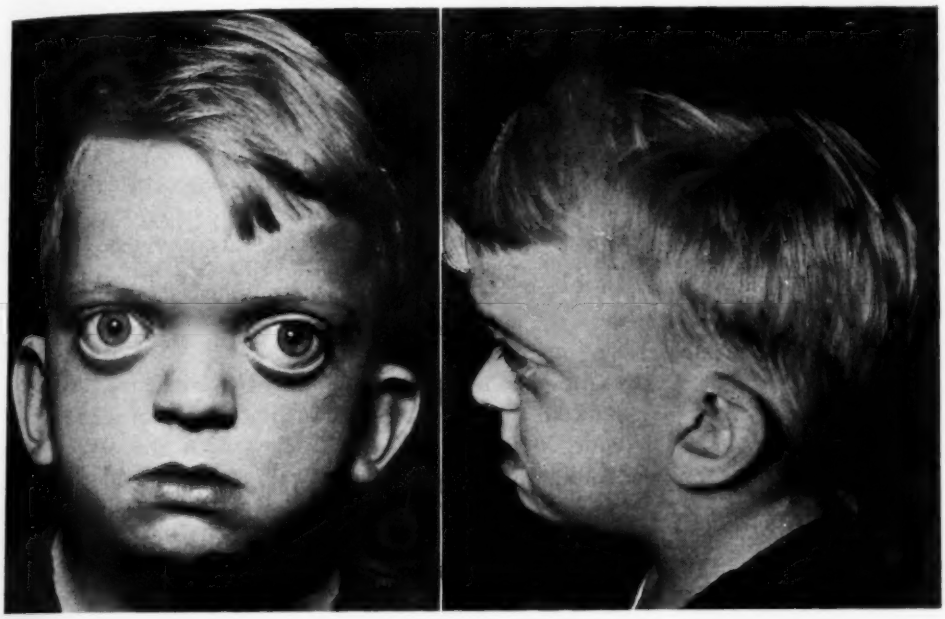


Fig. 4 (Vorisek). C. G. at 2½ years of age.

A roentgenographic report stated: "Views of the skull show a very small anterior fontanelle with marked digitations in the posterior portion of the skull. There is a marked bulging area on the forehead. The cranial plates are much thinner than normal. The sella turcica is normal in size."

In September, 1940, the patient was 2½ years old (fig. 4). The skull was now

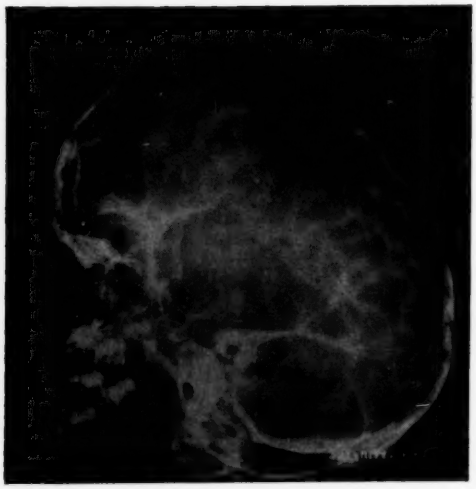


Fig. 5 (Vorisek). C. G., at same age as in figure 4. Side-view roentgenograph of skull.

quite high and narrow and the eyes were widely separated. There was binocular fixation for near, but slight exotropia for far. There was marked exophoria. The palebral fissures were very wide. Moderate exophthalmos was present, but the eyeballs were well covered by the closed lids.

The pupils were small and reacted normally. Through the small pupils both discs were seen to be moderately elevated, dirty gray in color, and with blurred margins. As well as could be determined the vision was fair, and the mentality was within normal limits. The exophthalmometer reading was R. 21.5 mm., L. 23.5 mm.; the distance between the two internal canthi was 31 mm., and the distance between the two external canthi, 82 mm.

A roentgenographic report in September, 1940, stated: "Views of the skull show a marked increase in the vertical diameter of the skull, marked thinning of the skull tables, and marked increase in all of the digitations. The sutures are prematurely closed. The orbits are widely separated. The sella appears to be markedly enlarged and the posterior clinoids are not seen. There is no evidence of intracranial calcification (fig. 5)."

Summary

Two typical cases of Crouzon's disease without hereditary implications are reported. One boy, who was observed for 5½ years, had decompressions of both cranium and orbit with unexpected success. The other boy, observed for only 2½ years, most probably should have decompressions at an early date.

104 South Michigan Avenue.

References

[1] Crouzon, M. O. Dysostose cranio-faciale héréditaire. Bull. et Mém. de la Soc. Méd. des Hôp. de Paris, 1912, v. 33, p. 545.

[2] Atkinson, F. R. B. Hereditary cranio-facial dysostosis or Crouzon's disease. The Med. Press, 1937, v. 195, Aug. 11, p. 118.

[3] Buchanan, D. N., and Krause, A. C. Dysostosis cranio-facialis. Amer. Jour. Ophth., 1939, v. 22, Feb., p. 140.

Ballantyne, A. J. Dysostosis cranio-facialis. Proc. Royal Soc. Med., 1937, v. 30, Jan., p. 280.

Ellis, R. W. B. Craniofacial dysostosis. Proc. Royal Soc. Med., 1937, v. 30, Aug., p. 1187.

Gareiso, Viviani, Cerdeiro. Craniofacial dysostosis. Rev. méd. latino-am., 1938, v. 23, Aug., p. 1245. Abst. Amer. Jour. Dis. Child., 1939, v. 58, Oct., p. 857.

THE MANAGEMENT OF STRABISMUS AT THE MILWAUKEE CHILDREN'S HOSPITAL*

JOHN B. HITZ, M.D.
Milwaukee, Wisconsin

In discussing this subject I shall limit myself to the consideration of manifest internal strabismus; further, rather than go into a lot of detail I shall try to touch the high spots and give some of our experiences with certain specific problems. One of the great problems in the discussion of orthoptics in the past has been the mutual understanding of the terms used; therefore, in so far as is possible I shall try to give our definition of terms concerning which there might be a misunderstanding. I do not promise that the definitions will be correct, but at least you will probably know what is meant.

On the first visit of a new patient a history is taken, a brief examination to determine the type of strabismus is made, and the patient given an appointment for an atropine refraction (drops at home thrice daily for three days). In this connection it might be well to mention that it is rare in our experience to be able to uncover the complete refractive error on the first examination. We prefer to repeat the atropine refraction at least twice during the period of preoperative observation or treatment, the patient, of course, wearing his full atropine correction in the interim. It is our conviction that the straightening of internal strabismus obtained from prolonged atropinization, with bifocals, is due primarily to the complete ciliary relaxation obtained, and that this can be accomplished equally well by repeated refractions.

The patient returns two weeks after receiving his glasses for a thorough check-up of vision, amount and type of deviation, deviation in the six cardinal directions, near point of convergence, status of fusion ability, and the like. The measurements of deviation are made wherever possible with the screen test, both with and without glasses. Fusion at distance and near is ascertained by means of the Worth four-dot test. Here possibly a word of caution is in order: In our experience it is possible at times to fuse the four-dot test, using an extramacular area in one eye; therefore, fusion of the four-dot test in the presence of a demonstrable manifest deviation should be taken as a probable sign of abnormal retinal correspondence. Studies of retinal correspondence are not made at this time, if any marked amblyopia is present.

Constant-patch occlusion is applied in all cases of amblyopia in which there is no demonstrable fundus lesion. We classify as amblyopia all cases in which there is a difference of two or more lines in the vision of the two eyes, using the Snellen chart or illiterate E chart. Patients who have an apparent eccentric fixation are given a trial of occlusion for one or two weeks; if macular fixation is not reestablished at the end of this period it is extremely unlikely that it ever will be. On the other hand a surprising number of patients will return to macular fixation at the end of this brief period of occlusion. Occlusion whenever possible is continued to the point of equal vision and alternate fixation, and in the case of proved abnormal correspondence to the time of surgical correction. Patients with alternating strabismus combined with abnormal correspondence are put on alter-

* Read before the Joint Meeting of Orthoptic Technicians and Ophthalmologists, at Cleveland, October 7, 1940.

nate occlusion until operation is performed.

Studies on retinal correspondence are made on the synoptophore, five to six checks being made before an opinion is established. At this point it would be well to define some terms. Normal retinal correspondence, it seems to us, can be defined as a habit mechanism wherein the mind fuses the images from separate nerve impulses derived from the stimulation of corresponding or near corresponding points or areas on the two retinas. In the same way abnormal correspondence is a habit mechanism that fuses or attempts to fuse images derived from the stimulation of noncorresponding areas. The first, then, can be classified as a good habit, the latter as a bad habit. If this concept contains any truth it means that the first hour a manifest strabismus is present the good habit of normal correspondence begins to be pushed into the background and the bad habit of abnormal correspondence comes to the fore. It is only when the bad habit becomes so firmly fixed that it is dominant most of the time that it can be diagnosed on the synoptophore, with the afterimage or red-glass test. This should explain the infinite variability of retinal correspondence in certain cases, in which the patient shows one thing one day, another the next, even showing abnormal correspondence at the beginning of a treatment session and normal at the end.

The development of abnormal correspondence may be pictured as the struggle of a bad habit to overcome a good one, and the treatment as a good habit overcoming a bad one. In many cases when the patient is first seen the two habits are fairly evenly matched, and the diagnostician may get confused pictures. In some cases the abnormal habit will be only poorly established, and occlusion, alone, will correct it. The statement has been made that retinal correspondence is so variable that it need not be considered in the treatment of strabismus. Is this not like saying, when on a sailboat in mid ocean, that the wind is too variable so we will pay no attention to it?

Abnormal correspondence is treated by macular massage on the synoptophore and constant occlusion. Treatment is continued until normal correspondence, fusion with amplitude, and, if possible, some degree of stereopsis is developed. In cases of normal correspondence training is instituted in order to increase fusion amplitude and develop stereopsis. Home treatment where possible is given to patients with definitely established normal retinal correspondence.

Our policy is to prepare these patients for eventual operation. In cases of constant internal strabismus we have been unable, except in rare instances, to straighten eyes and develop binocular vision without surgery (the diagnosis having been made after prescribing of lenses and correcting amblyopia); and in those exceptional cases we are inclined to credit some procedure other than the actual orthoptic exercises.

It is not in order here to discuss surgical procedures, except to say again that in our hands the large majority of the types of cases under discussion come to a surgical correction.

Let us stop and consider for a moment what the eventual goals are in the treatment of strabismus. Obviously the ideal is comfortable binocular vision with depth perception. Many patients do not go on to this ideal result, but develop partial binocular vision. Here again there must be a digression to define terms. A patient who develops binocular vision in our clinic must have no manifest deviation at 6 meters or 33 cm., must fuse the Worth four-dot test at 6 meters and 33 cm., and show depth perception of under 50 mm.

on the Howard-Dolman apparatus. We are using a small four-dot test, the visual angles subtended by the dots being 13 minutes, the distance between the dots 40 minutes. Patients showing fusion of the four-dot test and no manifest deviation at either distance or near but not both, are classified as having partial binocular vision.

Is the development of partial binocular vision as so defined worth the effort involved in the orthoptic procedure? We believe it is for two reasons; first, it prevents the development or recurrence of an amblyopia, and, second, it splints the eyes in position and prevents later deviations due to inexact surgical procedures. How close are we to accomplishing our goal in the treatment of strabismus? In selected cases—that is, eliminating cases of marked uncorrected amblyopia, marked anisometropia, cases of the type in which there is marked innervational anomalies as described by Bielschowsky, and patients with definite mental or psychological handicaps—we have found the following figures. These groups of cases are admittedly too small to draw definite conclusions, but we believe are large enough to show the trend.

Of 143 patients carefully studied, 57 percent showed abnormal retinal correspondence.

Of 34 patients with abnormal retinal correspondence given prolonged treatment, 58 percent were converted to normal retinal correspondence.

Of 24 patients treated with glasses, occlusion, pre- and postoperative exercises, 33 percent showed binocular vision as defined above and 41 percent showed partial binocular vision; a total of 74 percent.

Of 19 treated in the same manner, but without orthoptics, 26 percent showed binocular vision and 21 percent partial binocular vision; a total of 47 percent.

In no patient in these groups did any degree of binocular vision develop in the presence of an untreated abnormal retinal correspondence.

In checking our surgical results against the presence of abnormal or normal correspondence, in a group of 50 consecutive patients, unselected except for completeness of record, and all operated on by the same surgeon, it was found that averaging the distance and near deviations in 24 cases of normal retinal correspondence, correction of 85 percent of the deviation was obtained; in 26 cases of abnormal retinal correspondence, 69 percent of correction was obtained. These figures would seem to warrant the following conclusions:

1. The conversion of abnormal to normal retinal correspondence is possible in a high percentage of cases.

2. That orthoptics definitely increases the percentage of binocular vision obtained.

3. That a more complete surgical correction of the deviation can be expected in cases of normal retinal correspondence.

There are still many problems to be solved in the treatment of strabismus. A few of these which seem to puzzle us more frequently than others are:

1. Which cases to select for orthoptic procedures. It has seemed wise to eliminate cases of marked anisometropia, fixed abnormal correspondence (that is, cases in which no progress whatsoever is shown, after 6 to 10 treatments), innervational problems described by Bielschowsky, and obviously cases of the incorrectible amblyopia and paralytic types.

2. How to handle vertical anomalies. Of course the small vertical deviations constant in all fields can be helped by vertical prisms, and cases of definite single-muscle weakness can be handled surgically. It is the intervening types that constitute the real problem.

3. The management of aniseikonia,

which seems to be one of the basic causes of some types of strabismus.

In closing, a word of caution may be appropriate: Comfortable monocular vision is infinitely preferable to uncomfortable binocular vision. In each individual case this point must be kept in mind when orthoptic treatment is considered.

411 East Mason Street.

WHAT CAN BE EXPECTED OF ORTHOPTIC TRAINING?*

EDNA KNAUBER
New York

Desire for the achievement of a goal is one of the driving forces of man's existence. The goal of orthoptic training is the establishment or reëstablishment of normal, comfortable binocular vision with stereopsis. Orthoptic training can be expected to serve as the means for improving amblyopia ex anopsia, heterotropia, and heterophoria.

In amblyopia ex anopsia, it can be anticipated that the condition will improve more quickly and easily because of the intensified attention given when orthoptics are used as a procedure. An opportunity is presented to rate the patient's capacities and limitations, so that assigned tasks and exercises are within his ability. The interest of the patient is maintained by his knowledge that he is achieving progressively difficult feats. The child's parent is kept aware of progress through the regular and frequent observation of the child. When interest is maintained in this manner, the patching of "Johnny's" eye is not just an onerous task to be done haphazardly, or not at all. With improvement of vision or visual ability, the consecutive steps to proper eye coördination are easily followed. The attainment of these stages of appreciation of diplopia, superimposition, fusion, and stereopsis cannot be properly evaluated without careful and constant guidance.

As an aid to successful surgery, orthoptic training furnishes the method for study of the fusion status and grade of binocular vision. The necessary information concerning these points is gained through repeated visits, while a cursory examination will fail to give a true picture of the situation. Most important is the determination of whether the projection and retinal correspondence are normal. Correction of faulty correspondence *can* be accomplished in many cases, and an effort to inhibit the image in the false position should be made. With establishment of normal projection, postoperative return of the eye to abnormal retinal correspondence and its associate postural abnormality is guarded against. The reasons for preoperative training are definite. If there is no comparative background at the time when the child's sensations are new and strange, his understanding is handicapped. He should be taught how to interpret optical sensations that he has not experienced previously, so that the mechanics of coördination after operation may be more easily learned. Familiarity with the vocabulary he is expected to use in describing his visual reactions precludes better coöperation.

Postoperatively, the establishment of fusion and fusion range is essential to

---

* From the Manhattan Eye, Ear, and Throat Hospital Orthoptic Clinic. Read before the joint meeting of the Orthoptic Technicians and Ophthalmologists at Cleveland, October 7, 1940.

normal binocular performance. In many cases diplopia occurs, and the old habit of suppression or alternation will assert itself unless the mind is taught to accept superimposition and fusion. The accommodation-convergence relationship may

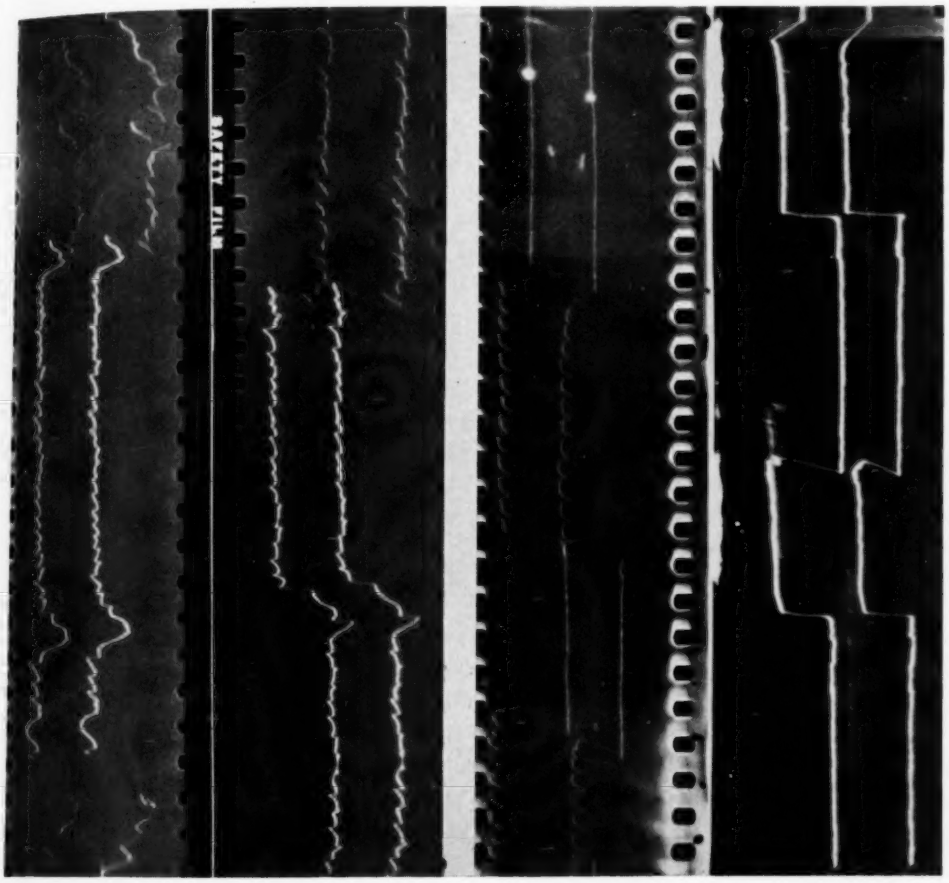


Fig. 1 (Knauber). Ophthalmograph film of fixations looking left and right. Left hand films show condition before treatment, right hand ones after.

never have been formed and at any rate might be imperfect. Training to institute the proper ratio of these functions will facilitate natural performance. Despite the fact that binocular vision may occur spontaneously, the ultimate in comfort and stereoscopic appreciation is best obtained by orthoptic follow-up.

In heterophoria, in which asthenopic symptoms are present, orthoptic training will produce most satisfactory results. There are few people who can obtain results from a self-administered program of vergence exercises. The patient who is given home prism exercises, will often return to the ophthalmologist with all manner of excuses for not having done them, but still complaining of his symptoms. With orthoptic training the patient is under specific direction and guidance. His exercises are made as interesting and varied as possible. Psychologically, the adult reacts as does the child to the stimulus of knowledge of achievement. Relief

from his discomfort is accelerated, due to intensified treatment.

Unstable fixation is often present in cases of phoria with either convergence insufficiency or divergence insufficiency, showing an unbalanced fusion range. In two cases, illustrating each of these muscular imbalances, the patients after two to three weeks of orthoptic training had an improved capacity for fixation although there was still some variability in the position of the eyes (fig. 1). Both of these patients reported relief from symptoms and improved visual ability.

These conclusions are drawn from observations in the Manhattan Eye, Ear, and Throat Hospital Orthoptic Clinic, where the yearly average is approximately 6,000 patient visits. The coöperation and response of our patients assures us that they must be receiving comfort and satisfaction from the therapy of orthoptic training.

Manhattan Eye, Ear and Throat Hospital.

Discussion

Dr. R. Townley Paton* (New York): Whenever the subject of orthoptics is presented by some well-trained orthoptist and a discussion held, I feel that none but the expert in this field is qualified to participate. When we survey the field, there are few indeed who have the necessary qualifications, but many who like myself would like to express an opinion. Though I do not belong to that mythical All-American team, my remarks may carry sufficient weight further to strengthen Miss Knauber's observations.

The value of orthoptics from a diagnostic point of view is unquestionable so long as it is combined with other methods of muscle study. Nearly every case seen by Miss Knauber was also studied in the muscle clinic, and several careful refractions made as each case was followed. The difficulty of the work in the orthoptic clinics is not with our trained technicians but with the doctors. Ten years ago and less, most of us looked on orthoptic equipment as playthings, with not much practical application except as an aid to diagnosis. Today, orthoptics has become of great therapeutic value, but there are many ophthalmologists who do not think it worth the effort. I have heard it said over and over again that a good operator can straighten the eyes of a cross-eyed child without the help of orthoptics. When asked about the physiological result, the answer has frequently been, "There have been plenty of cases in which annoying diplopia has been produced by orthoptic training, which had better been left alone." If this is the prevailing attitude among certain ophthalmologists, we had better find out the reason for such statements. And, mind you, there are many who think such thoughts though they may feel that discretion is the better part of valor. My own feeling after careful observation is that the men who make such statements have no working knowledge of the science of orthoptics, and have never taken the trouble to follow the work of such well-trained technicians as Miss Knauber. As to the aforementioned diplopia, I would rather take the time to explain the reason to those men who do not believe in the value of orthoptics, and let you from your greater knowledge of the subject reflect on the possible conclusions one might reach.

In one sense at least, I feel that orthoptics is at the crossroads. Mechanically, there will no doubt be some improve-

* Manhattan Eye, Ear and Throat Hospital.

ments. The work on aniseikonia is and will become more and more closely tied up with what is being done in the field of orthoptics. As a purely mechanical phase of treatment orthoptics has perhaps reached its limits in the hands of the expert. New discoveries will no doubt come from several sources, most important of which may be from a study of human behavior. We must begin with a fundamental study of the individual, reaching back to the earliest years of life. We must start the study at the point where the life of the organism begins. The studies of animal and human fetal behavior and development have shown conclusively that life after birth is but a mere repetition of what has been going on in embryonic life up to the time of birth. The problem of amblyopia will be better understood and more easily dealt with when the conditions under which it arises are known. Each function, whether it be respiration, digestion, or vision, has its counterpart in early embryonic development. Possibly many ocular disturbances attributable to fusional incongruities have a common factor found only at the time when somatic behavior begins. The germinal stage is considered to end at the end of the second week when the true fetal period begins. Shortly after this the cerebral and optic vesicles begin to be differentiated. The behavior pattern of the individual develops in a regular sequential order. Psychiatrists and child psychologists must have their interest aroused in the problems we are dealing with if the science of orthoptics is to leave the crossroads and progress toward a better understanding of the fundamental factors involved in children with heterotropia.

Let those of us who, like Miss Knauber, have helped through tireless effort to substantiate the theories evolved by others prepare ourselves for a more fundamental understanding of the problems we are dealing with.

GONIOSCOPIC OBSERVATIONS IN CYCLODIALYSIS OPERATIONS*

SAMUEL TRACY CLARKE, M.D.
Boston

Since the advent of cyclodialysis, advocated first by Heine, there has been a great deal of discussion as to its mode of action in lowering the tension in glaucoma. Perhaps the most interesting recent work on the subject is that of Barkan, who made gonioscopic studies of the angle in 10 cases of cyclodialysis, and found the suprachoroidal space to be open in 7 cases and closed in 3. All seven cases in which the cyclodialysis resulted in a permanent opening from the anterior chamber to the suprachoroidal space were successful from the standpoint of control of tension, while the three cases in which no such permanent opening was obtained were all surgical failures. This report tends to give substance to the theory that a cyclodialysis arrests glaucoma by allowing the aqueous free access to the suprachoroidal space where it is then absorbed.

In an attempt to prove Barkan's findings, a series of 34 cyclodialysis cases were observed, both clinically and gonioscopically. No case is reported unless the end result of the operation was observed for a long enough time to be sure either of its eventual success or failure. A white and quiet eye with tension of 22 mm. Hg (new Schiötz) or less, over a three-month period, was used as a criterion of success. Unfortunately, it was impossible to perform gonioscopy in all these cases before operation.

Before discussing the statistical results of this summary, it might be interesting to pause for a few observations about the operation of cyclodialysis in general. If the operation is successful, the great majority of patients run a low normal tension thereafter. Usually this tension varies between 12 and 16 mm. Hg (Schiötz) and no cases of hypotony were observed following cyclodialysis. However, in this regard the following case is of interest:

P. B., a 16-year-old white boy, suffered a severe contusion of the left eyeball in 1939, at which time he came in to the Massachusetts Eye and Ear Infirmary with a very shallow anterior chamber. He had a marked hypotony and showed nothing else except a slight hyphema that rapidly disappeared, but the anterior chamber remained shallow and the hypotony continued. There was no evidence of traumatic cataract and the fundus was normal with no sign of separation of the choroid. Atropine and other mydriatics were used for several months without appreciable effect. Miotics were then tried, but the shallow anterior chamber and hypotony remained.

Nine months later he was sent in for gonioscopy and, in spite of the almost empty anterior chamber, it was possible to see a very large opening leading into the suprachoroidal space extending from the 12-o'clock to the 7-o'clock position. This opening covered about one third the circumference of the angle and very likely acted as a large cyclodialysis, producing hypotony. However, one would also have to consider the effect of such trauma and choroidal separation on the aqueous-production apparatus, especially the ciliary body lying over the separation. This case might make one think that it is possible to cause hypotony by performing too large a cyclodialysis.

* From the Howe Laboratory of Ophthalmology, Harvard Medical School, Massachusetts Eye and Ear Infirmary. This work was supported by a grant from the John and Mary Markle Foundation of New York, New York.

Blood in the anterior chamber following the operation is certainly a poor prognostic sign, although if it is small in amount it usually does no harm. Two cases were observed in which the mouth of the cyclodialysis was found to be open three or four days after operation, but with some collection of blood in the mouth of the suprachoroidal opening. The tension immediately following the operation and for several weeks thereafter was low normal, but as the blood began to organize, the traction of scar tissue could be seen closing the cyclodialysis opening. The tension gradually rose and further surgery had to be done. For this reason it is undoubtedly a good procedure to do one's cyclodialysis operations on the globe above, and to prop the patient up at a 30-degree angle immediately after the operation. This not only allows gravity to pull the choroid away from the sclera at the site of operation, but tends to make the blood, if present, gravitate to the lower part of the anteror chamber, where it will not interfere with the newly established opening. The postoperative use of miotics is another good procedure tending to keep the new-formed opening patent, although occasionally the advent of iritis makes the use of atropine imperative. Any surgical procedure where permanent drainage is to be established could be expected to be more effective if a location were selected at or near the iris angle where there was present the least amount of scarring or anterior synechiae from former disease or surgery. Therefore, the sooner any glaucoma operation is performed in the course of the disease, the better its chance of success. Similarly, the more operations performed in the same vicinity, the less their respective chance of success will become.

An example of improper use of cyclodialysis is seen in the case of M. B., a 46-year-old woman, on one of the charity services at the Massachusetts Eye and Ear Infirmary, who had simple chronic glaucoma in the right eye, uncontrolled with miotics, and complicated by aphakia. A cyclodialysis was performed in January, 1939, in the upper nasal quadrant, which lowered the tension to normal for about six weeks. In spite of miotics it rose to 38 mm. Hg (Schiötz), and in March another cyclodialysis was performed by a different surgeon but in the same place on the eyeball that had been utilized previously. Gonioscopy performed two days after this operation revealed complete closure of the iris angle by anterior synechia all the way around, and no evidence of any opening into the anterior chamber. There was, however, a thin line of blood just anterior to Descemet's membrane. On close inspection with the corneal microscope it was then evident that the operator had split the cornea just anterior to Descemet's membrane and never really opened into the suprachoroidal space at all. In going into the operative history with the house officer who had been present at the operation, it was ascertained that considerable difficulty had been encountered in trying to force the iris repositor from the scleral incision into the anterior chamber, and that no aqueous had been obtained on withdrawal. The impression had arisen at this time that something was amiss. The tension stayed down only a few days after this operation, probably because of the adrenalin in the retrobulbar novocaine injection used for anesthesia. A week or so later, the house officer asked me to look at the patient again with the gonioscope, as he had done another cyclodialysis, and again at the same site. This time there had resulted a fairly good opening into the suprachoroidal space, but there was a moderate amount of blood present near the mouth of this opening and quite a bit of roughened area on the posterior sur-

face of the cornea and sclera at this point. Within two weeks the tension was up again and the cyclodialysis opening had closed. If more attention had been paid to the patient's previous record and gonioscopic studies, this sad ending might have been avoided.

Thirty-four patients were studied in this series by gonioscopic examination after they had had cyclodialysis operations. Fourteen of these patients were examined before operation:

Before Operation	*Angle Open*	*Angle Closed*
	4	10
Successful operative result tension under 24 mm. Hg (Schiötz for three months	3	0
Failures, tension over 30 mm. Hg (Schiötz) in spite of drug therapy. Also within three months of operation	1	10

The successful cases all showed a permanent opening into the suprachoroidal space postoperatively, and at the end of three months. In none of the failures did such an opening remain patent after the tension went up; in fact, most of them were closed within two weeks of the operation.

Twenty cases were examined postoperatively only; so that the condition of the angle before operation was unknown. Of this group 15 were failures and 5 were successes under the above-mentioned criterion. Here again, the successful cases all showed a permanent opening into the suprachoroidal space and the failures showed no such permanent opening. In general, one can say that if the cyclodialysis operation results in a permanent opening into the suprachoroidal space, the glaucoma is controlled.

As exceptions, there are two interesting cases not included in this series where large permanent openings into the suprachoroidal space were obtained following cyclodialysis, and yet the glaucoma was uncontrolled. Both of these cases were in young people who had traumatic cataracts followed by lens extraction and secondary glaucoma. Multiple operations had failed to control the tension before the cyclodialysis was tried and both eyes went on to blindness.

The reason for the poor results obtained from the cyclodialysis operation in this series is probably because in Boston it is an operation of last resort, usually limited to aphakic eyes. Therefore, most of the cases on which it is used have closed angles preoperatively and, as shown in the table, this type of case is not one on which much success is obtained by cyclodialysis. Undoubtedly, if the operation were held in higher favor here, it would be performed on more favorable cases and results would compare more favorably with those obtained elsewhere in this country.

Summary

These findings bear out Barkan's report as to the mode of action of the cyclodialysis operation, and as to the gonioscopic findings following both the successful and unsuccessful operations. Anterior peripheral synechia would seem to be a definite contraindication to the procedures being carried out in the region of the synechia.

403 Commonwealth Avenue.

BITÔT'S SPOTS IN TRINIDAD

VIVIAN M. METIVIER, F.R.C.S. ED., D.O.M.S.*
Port-of-Spain, Island of Trinidad

The ophthalmic symptoms and signs of frank vitamin-A deficiency have been frequently described, and Bitôt's spots have come to be regarded by oculists as a diagnostic sign of xerophthalmia. Many medical men and women have produced works and written papers in support of that view during the last 10 years, among whom are Collins (1930), Eusterman and Wilbur (1932), Mackay (1934), Loewenthal (1935), and May and Wolff (1938). In a more recent period medical practitioners in warm climates have made contributions to the literature of Bitôt's spots and related conjunctival appearances which throw new light on their significance. After considering reports from 48 different colonial territories, the Committee on Nutrition in the Colonial Empire published a "First report: Nutrition in the Colonial Empire" (1939). In paragraph 78 of this first report, part 1, the committee state that "the prevalence of Bitôt's spots and xerosis of skin and hair are probably also due to insufficiency of vitamin A"; and in the preceding sentence xerophthalmia is said to be one of the eye conditions caused by vitamin-A deficiency. Are Bitôt's spots not included in the term xerophthalmia? Does xerophthalmia mean only xerosis of the cornea? Are there several kinds of Bitôt's spots? Does xerosis of the conjunctiva refer only to thickening, dryness, wrinkling, and pigmentation of the epithelium? It is hoped that these notes may help, both directly and indirectly, to provide answers to these important questions.

Bitôt gave us his description in 1863, and Mackay (1934), Aykroyd and Rajagopal (1936), and May and Wolff (1938) tell us what typical Bitôt's spots are like. Hoat (1936) has published a photograph of them, and tells how parents in Keboemen, Dutch East Indies, practice licking off the "froth" or "foam" and bring their little ones to be treated for "Wormfaeces," the name they give to Bitôt's spots. H. de Villers (1935) regards Bitôt's spots as a sign of xerosis of the conjunctiva under the heading, xerophthalmia. Palmer (1936) has given a description of three different forms of xerosis of the conjunctiva seen by him in Assam: one as if a fine white powder had been dusted into the eye and adhered on each side of the cornea; another with a sort of white foam; and a third with an appearance comparable with the belly of a sardine. The last-mentioned points to pigmentation of the conjunctiva (studied by Pillat, 1929-1933; Collins, 1930); and in Trinidad, out of a total of 51 school children with prexerosis and xerosis conjunctivae, examined in 1938 at the Colonial Hospital, San Fernando, 31 had conjunctival pigmentation. They were practically all East Indians, 25 boys and 6 girls, and this sex distribution agrees with the findings of Hoat (1936) and of Sie-Boen-Lian (1938). I believe that boys are more prone to develop Bitôt's spots because they spend more time in the hot sun in work and play.

Singh (1934) goes further than any other observer. He described how the ocular conjunctiva in the palpebral aperture on the temporal side assumes a thick, fatty-looking appearance of a dirty yellow or brownish color in East Indian

* Ophthalmic Surgeon, Colonial Hospitals, Trinidad.

children, the affected conjunctiva wrinkling into coarser folds as the eyeball moved laterally; and he considered that condition the earliest clinical sign of vitamin-A deficiency, Bitôt's spots being absent. Youmans and his co-workers (1938) found that the examination of conjunctival scrapings was inadequate in the diagnosis of slight vitamin-A deficiency in adults. They were seeking a means for the detection of slight vitamin-A deficiency because they found that dark-adaptation tests were difficult or impossible to use in small children or uncoöperative adults; and they argued that changes in the skin were not suitable as a reasonably constant diagnostic sign. (Tansley, in 1939, asserted that most of the dark-adaptation curves for vitamin-A deficiency are quite worthless; Thomson and his co-workers, in the same year gave their reasons why it is impossible to be certain how far recorded observations represent physiological facts; Harris and Abbasy, also in 1939, found that the dark-adaptation test is intricate, needs experience and careful controlling, and is not suitable for routine use by school medical officers.) Nicholls and Nimalasuriya (1939) said that much work will be necessary to define the range of texture and pigmentation of the sclerotic conjunctiva of races with dark skins before epithelial thickening and pigmentation may be used as an indication of vitamin-A deficiency.

Photomicrographs of "Conjunctival scrapings in xerophthalmia" (Therapeutic Notes, 1937) had previously attracted my attention; and, in answer to my letter, Dr. R. H. Watson wrote saying that the scrapings had been made from rats that were allowed to become vitamin-A deficient until well-marked xerophthalmia developed. A similar condition to that described by Singh is seen in Trinidad in East Indian children; and as the result of clinical observation I believe that it is related to the type of Bitôt-spot formation seen in Trinidad East Indian children. I include it, with other forms of dryness, wrinkling, loss of luster, and pigmentation of the temporal bulbar conjunctiva, under the heading "prexerosis conjunctivae," when Bitôt's spots cannot be made out with the aid of a corneal loupe. Unfortunately, the condition has been called xerophthalmia in Trinidad and recorded as evidence of frank vitamin-A deficiency. In my experience, it does not respond to treatment with fish-liver oils and other vitamin-A preparations. Hoat referred to two groups of cases in the Dutch East Indies, although he says nothing of different forms of conjunctival xerosis. He speaks of those walking around in the villages, still sturdy and strong, with only the Bitôt's spots noticeable, and clinic patients who suffer more severely with corneal and other complications. The former grouping is the one met with in Trinidad and also in Ceylon, according to Nicholls. I have never seen in Trinidad the typical white triangular areas described by May and Wolff and others. Bitôt's spots in Trinidad belong to the type described by Palmer in Assam and Nicholls in Ceylon, but all my patients were found to have what looked like foam or fine spray. Nicholls and Nimalasuriya say that the Bitôt's spots in no way resembled foam in the great majority of their cases, and they lay stress on the fact that it is a form of white striation that they call Bitôt's spots. They go on to suggest two forms of xerosis of the conjunctiva, one more acute with the formation of foam spots, and another without them, due to a more chronic type of tissue reaction seen among populations who have become biologically adapted to diets deficient in vitamin A. I support Nicholl's theory, but without the experience of identical clinical findings.

Nicholls saw Bitôt's spots on the nasal

side of the eyeball in less than 2 percent of his cases, but in Trinidad no change was ever found in the nasal bulbar conjunctiva of our patients. Nicholls found that Bitôt's spots often affected one eye only; and two patients with that condition in Trinidad are of special interest. When tylosis completely protected the conjunctiva of the right eye of an East Indian school boy from very early life, that eye did not develop Bitôt's spots although the normally exposed left eye had them. An East Indian girl of 16 years had an abnormally exposed temporal conjunctiva of the left eye, the result of proptosis with outward and downward deviation of the globe caused by a nasofrontal "osteoma." That eye had Bitôt's spots while her right eye, in its normal position, did not develop them. Both patients were observed for several years, and treatment made no difference to the conjunctival appearances.

Mackenzie (1939) has given us a good account of the development of Bitôt's spots, in acute form, in persons forced to live almost exclusively on diets such as maize-meal and beans in East Africa. Those who developed the spots formed 25 percent of cases of night blindness; and night blindness had invariably preceded the development of the spots. Nicholls found that most of his patients did not have night blindness, and only one of my patients with Bitôt's spots suffered from that condition. This shows that patients with the chronic type of Bitôt-spot formation do not have night blindness; and in Trinidad it is also exceptional to find children with Bitôt's spots or "prexerosis conjunctivae" who have signs and symptoms of other vitamin deficiencies. My records show that the boy with night blindness had phrynoderma as well, and that one school boy with xerosis of the conjunctiva had angular stomatitis due to ariboflavinosis, the local name for which condition is "wappia." (I can remember school boys attempting to hide the abnormal appear-

TABLE 1

STATISTICAL DATA OF VITAMIN-A DEFICIENCY

Colonial Hospital	Period	Night Blindness	Xerosis Corneae	Prexerosis Conjunctivae	Xerosis of Conjunctiva	Keratomalacia	Total Patients
Port-of-Spain	August, 1935, to December, 1938	3	1	2	6	6	2,662
San Fernando	May, 1932, to December, 1938	8	1	23	44	3	7,943

SCHOOL CHILDREN ONLY (3 TO 14 YEARS) 1938

Colonial Hospital	Night Blindness	Prexerosis Conjunctivae	Xerosis Conjunctivae	Errors of Refraction	Folliculosis Conjunctivae	Other Cases	Total Patients
Port-of-Spain	Nil	2	3	25	27	157	215
San Fernando	1	17	34	22	35	75	184

An analysis of records for 1939 and 1940 would show an incidence similar to that given above, except in the case of school children, who, after 1938, were no longer sent for treatment of xerosis of the conjunctiva, a few of them being referred in cases of doubtful diagnosis only. At San Fernando, 631 children were referred to the hospital eye clinic by the school medical officer in 1938; and of that number only 184 attended, parents not regarding the eye condition of sufficient importance to make them seek advice. The 631 children were selected from 3,172 examined by the school medical officer in 1938, and of that number 1,958 were boys and 1,214 girls. (The earliest date given at each hospital corresponds to a first appointment.)

ance with ink, and have seen adult patients use black shoe polish for the same purpose.)

Mackenzie noted the rapid disappearance of Bitôt's spots after treatment with large doses of vitamin A had been started. Spence (1931) found that they were diminished within a week of commencing regular treatment with cod-liver oil, and that the spots disappeared in the worst

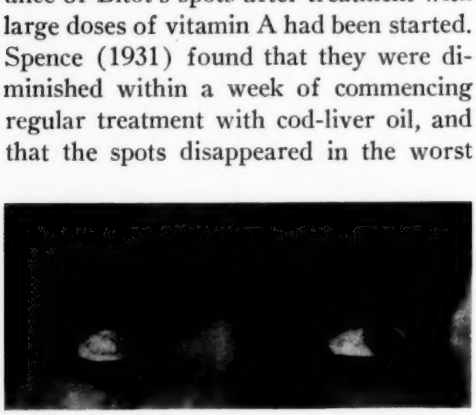


Fig. 1 (Metivier). Right eye shows conjunctival thickening, pigmentation, and foam on the temporal side. The nasal side of the left eye shows a little pigmentation only. The patient, G. R., had Bitôt's spots for five and one-half years when the photograph was taken.

cases by the fifth to sixth week. H. de Villers (1935) and Aykroyd and Rajagopal (1936) have made similar observations. In Trinidad I have treated many children and a few young adults with fish-liver oils and other vitamin-A preparations without any change taking place in their Bitôt's spots. Palmer (1936) had mentioned the great difficulty he experienced in Assam in curing certain cases of xerosis of the conjunctiva with vitamin-A preparations. Like myself, he had found adexolin a valuable preparation in the treatment of xerosis of the cornea and commencing keratomalacia. (Adexolin contains 12,000 international units of vitamin A per cubic centimeter.)

Table 1 gives statistical returns of vitamin-A deficiency in the eye department of both Trinidad colonial hospitals. It will be seen that xerosis of the cornea is a rare disease and keratomalacia infrequently met with in Trinidad. San Fernando Hospital provides for the needs of the large sugar-cane and oil-field industrial populations; and only three boys and a young man of 21 years were seen with Bitôt's spots during the first 5 years of my work there. After September, 1937, school medical officers began to send children with Bitôt's spots and other related conjunctival appearances to the out-patient eye clinics at my request. They were nearly all East Indians, but one was of Portuguese parentage and five others of Negro descent. After 18 months' experience with the school children it was found that there was no response to treatment both in the xerosis and prexerosis conjunctivae patients. It was then decided that they should no longer attend ophthalmic clinics for treatment; an educational campaign in the schools would be of more value, and a pictorial poster has been prepared, to my design, for that purpose. It is based on a form of appeal that I have found useful when giving dietetic advice to patients suffering from all forms of avitaminosis affecting the eye. They are asked to take notice of all the colors and shades around them, in and out of doors. "If you want your eyes to keep healthy and to see clearly without objects becoming smoky or misty, without watering and blinking, you must not eat white foods only, but foods of all colors, especially those of the commonest colors seen." With that, a list of suitable articles of diet is given.

The Trinidad school children with xerosis of the conjunctiva were given cod-liver oil; a few of them had adexolin as well. Admission to the hospital, treatment for worms, and a good diet, supplemented with citrus fruit, bemax, green vegetables, raw tomatoes, and dairy produce brought about no change in the Bitôt's spots and related conjunctival changes. There was one exception, an East Indian

boy of seven years, already mentioned, who suffered from night blindness and phrynoderma. His Bitôt's spots disappeared.

One boy, G. R., impure Negro, was first seen when nine years old in 1934. He had two long periods of treatment and was observed for five and one-half years. For six weeks, November-December, 1939, he had adexolin and was carefully examined, observed, and dieted at my own home. His Bitôt's spots remained unchanged. Another boy of Negro strain, L. S., aged two years, was treated for 10 months in 1940. He was cured of ascaris infestation and dieted and given adexolin in the hospital. Finally, he had two 8 c.c. bottles of prepalin, over a period of two weeks, out of a supply kindly given to me by Glaxo, Ltd. His Bitôt's spots remained unchanged. This boy has three sisters, aged 5, 7, and 9 years, without conjunctival changes. (Prepalin is an olive-oil solution of vitamin A, 72,000 international units in each cubic centimeter.)

Sie-Boen-Lian (1938) observed 19 cases of Bitôt's spots in Java in which deficiency of vitamin A was clinically and biologically excluded; and he came to the conclusion that Bitôt's spots are by no means a positive sign of deficiency of vitamin A. He says that the majority of his patients affirmed that they had the spots in early childhood and even believed that they were present from birth. Similar statements have been made to me by Trinidad parents and young adults. This difficulty or impossibility of curing Bitôt's spots with vitamin-A preparations in certain groups of patients is fairly well recognized among persons with pigmented skins, for Palmer, Sie-Boen-Lian, Aykroyd, and Rowland Wilson (personal communications, 1938), Nicholls, and I have had experiences, more or less the same, in Assam, Java, South India, Egypt, Ceylon, and Trinidad. The records of observers in different parts of the world have been collated and brought into relationship with experience gained in Trinidad in order to bring out the full meaning of Bitôt's spots and other related conjunctival appearances.

Summary and conclusions

Xerophthalmia means xerosis of the cornea or xerosis of the conjunctiva. Both the cornea and conjunctiva of an eye are affected with xerosis at the same time when frank deficiency of vitamin A is well established and active. I have never seen both cornea and conjunctiva affected with xerosis in the same patient; and patients suffering from xerosis of the cornea in Trinidad belong to a totally different clinical group to that of persons with xerosis of the conjunctiva. The precise application of the term xerophthalmia should be stated in nutrition-survey records. That is imperative whenever nonophthalmologists may use the term to include forms of alteration in color, texture, and luster of the temporal bulbar conjunctiva that are not generally accepted, by themselves, as indicating avitaminosis A. The term, prexerosis conjunctivae, is suggested for those changes when Bitôt's spots are not made out, even with the aid of a corneal magnifier. (Loewenthal, in 1935 says that early Bitôt's spots are easily overlooked unless a powerful lens is employed; Aykroyd and Rajagopal, in 1936, include only cases showing Bitôt's spots visible to the naked eye in final records, although they noted all degrees of dryness of the conjunctiva.)

Xerosis of the conjunctiva may be either acute or chronic in type; and Bitôt's spots, visible to the naked eye, are a sure sign of its presence. The spots occur in the same geographical area, in both the acute and chronic form, almost

exclusively in warm climates among persons with dark skins. Then, also, they tend to vary a good deal in their clinical appearance, being modified by the amount of dryness, thickening, and pigmentation of the keratinized conjunctival epithelium that has taken place. In addition to that, the amount of meibomian secretion, epithelial débris, and wrinkling surface epithelium present helps to modify the clinical picture; and the formation of thick masses of frothy material, white striated areas, specks of foam, or a very light spray determines the type of Bitôt's-spot formation over an area that is not always the same in size, shape, or proximity to the corneal margin. In some persons Bitôt's spots are a diagnostic sign of active vitamin-A deficiency; among other individuals they have no morbidity significance. Once the process of Bitôt's-spot formation has begun insidiously cornification of conjunctival cells may continue indefinitely beyond ordinary limits, with the value only of a physiologic variation. Certain persons become biologically adapted, under suitable conditions, to the low vitamin-A diet that custom and prejudice have caused them to adopt; and Bitôt's spots may be said to endure with them as an expression of nationality rather than as the indication of social evils arising from economic distress. The ultimate test is the curability of the spots with vitamin-A preparations. In Trinidad, Bitôt's spots were not seen in adults over the age of 21 years. There was only one exception, an East Indian woman of 40 years whose spots were made out with the aid of a corneal loupe.

I agree with Aykroyd (1937) and other observers in making the coexisting incidence of angular stomatitis, phrynoderma, and Bitôt's spots a simple and useful method of assessing the state of nutrition among large groups of children in tropical countries.

References

Aykroyd, W. R. Brit. Med. Jour., 1937, v. 2, p. 1008.

Aykroyd, W. R., and Rajagopal, K. Indian Jour. Med. Res., 1936, v. 24, p. 419.

Collins, E. T. Trans. Ophth. Soc. U. Kingdom, 1930, v. 50, p. 223.

de Villers, H. South African Med. Jour., 1935, v. 9, p. 13.

Eusterman, G. B., and Wilbur, D. L. Jour. Amer. Med. Assoc., 1932, v. 98, p. 2054.

Harris, L. J., and Abbasy, M. A. Lancet, London, 1939, v. 2, p. 1355.

Hoat, Oey Djoen. Geneesk. Tijdschr. v. Nederl.-Indië, 1936, v. 76, p. 1101.

Loewenthal, L. J. A. Ann. Trop. Med. Parasit., 1935, v. 29, p. 407.

Mackay, H. M. M. Arch. Dis. Child., 1934, v. 9, p. 65.

Mackenzie, Alan. Lancet, London, 1939, v. 2, p. 341.

May, Q. I., and Wolff, Eugene. Lancet, London, 1938, v. 2, p. 252.

Nicholls, L., and Nimalasuriya, A. Lancet, London, 1939, v. 1, p. 1432.

Nutrition in the Colonial Empire. London, 1939.

Palmer, F. J. 1936. Quoted in Nutrition, Glaxo Labs. Ltd., published by I. T. A., Calcutta, 1938, v. 4, p. 142.

Pillat, A., and King, G. Brit. Jour. Ophth., 1929, v. 13, p. 506.

Pillat, A. Arch. of Ophth., 1933, v. 9, p. 25.

Sie-Boen-Lian. v. Graefes Arch. f. Ophth., 1938, v. 139, p. 17.

Singh, S. B. Brit. Med. Jour., 1934, v. 1, p. 193.

Spence, J. C. Arch. Dis. Child., 1931, v. 6, p. 17.

Tansley, Katherine. Brit. Jour. Ophth., 1939, v. 23, p. 161.

Therapeutic notes. Parke Davis & Co., 1937, v. 44, p. 244.

Thomson, A. M., Griffith, H. D., Mutch, J. R., and Lubbock, D. M. Brit. Jour. Ophth., 1939, v. 23, p. 461.

Thomson, A. M., Owen, E. C., and Logaras, G. Brit. Jour. Ophth., 1939, v. 23, p. 697.

Youmans, J. B., Corlette, M. B., Corlette, M. G., and Frank, H. Jour. Lab. Clin. Med., 1938, v. 23, p. 663.

OBSERVATIONS ON THE CHEMOTHERAPY OF TRACHOMA*

A. R. McKelvie, M. B.Ch.B., D.O., D.O.M.S.,
R. Kirk, M.D., B.Sc., F.R.F.P.S.G., D.P.H., and H. J. Holder
Khartoum, Anglo-Egyptian Sudan

Introduction

Since Lian[1] in the Dutch East Indies, Loe[2] in America, and Kirk, McKelvie, and Hussein[3] in the Sudan reported independently that sulphonamides have a remarkable effect in the treatment of trachoma, a considerable literature has accumulated on the subject. A number of criticisms have been raised, but the original observations have been amply confirmed. Although sulphonamides taken by the mouth may not cure every case of trachoma, they have already taken a useful place in the treatment of this disease, particularly in cases with corneal complications, such as pannus and keratitis.

The scope of our earlier communication was restricted merely to recording what appeared to be a remarkable reaction to chemotherapy in a supposed virus disease. No attempt was made to explain this, or to compare the results in detail with those obtained by other methods of treatment.

During the past two years attempts have been made to investigate more fully the action of sulphonamides in trachoma. The inquiry has proceeded along two main lines. The first, largely clinical, is to assess the effect of sulphonamide therapy in different varieties of the disease, in order to separate the types that are likely to derive most benefit from the drug from those in which the benefit is slight or doubtful. The second, of more theoretical interest, is to determine how these compounds act, whether they influence directly the causal agent of trachoma or merely eliminate the effects of superimposed bacterial infection.

Since the so-called virus of trachoma cannot be grown in artificial-culture media or maintained in any of the laboratory animals at our disposal, the work has necessarily been restricted to clinical and laboratory observations on trachoma patients coming to the Ophthalmic Department of Khartoum River Hospital. Many of the observations are incomplete, since clinical experiment must always be subservient to the primary functions of the hospital; namely, treatment and the prevention of complications, of which blindness is the most serious and important.

The general trend of these observations has been to amplify rather than alter any of the conclusions reached in our earlier paper, without producing any definite evidence as to the manner in which sulphonamides act in trachoma. For this reason it was our intention to defer publication until further data had been accumulated, but since the outbreak of hostilities in East Africa it is unlikely that it will be possible to continue this work. The data already accumulated, however, are not without interest. At the present stage it is possible to indicate those types of the disease as seen in this country in which sulphonamide therapy is beneficial, and those in which it has little or no effect. In addition, a number of observations have been recorded which may have some bearing on the manner in which cure is effected.

Dosage and toxicity

Three compounds were used, sulphanilamide (Prontosil album), proseptasine (M.&B. 125), and sulphapyridine M.&B. 693). No difference in therapeutic effect could be noted among the three drugs, so in the observations which fol-

*From the Stack Medical Research Laboratories.

low they are all referred to as sulphonamide, and no differentiation is made between cases treated by one or other of the compounds. No hard-and-fast scheme of dosage was used, but as a result of previous experience the following tentative system was adopted as a basis:

(a) *Sulphanilamide* (Prontosil album). For adults, one tablet (0.5 gm.) thrice daily; for children 10-15 years, half a tablet (0.25 gm.) thrice daily; and for children 5-10 years, half a tablet (0.25 gm.) twice daily. Initial course up to a maximum of 21 days, followed by a rest period, and then if necessary further treatment among similar lines.

(b) *Proseptasine and sulphapyridine.* For adults, four tablets (2.0 gm.) a day, at the rate of one tablet (0.5 gm.) at four-hour intervals, for a period of 15-21 days; for children 10-15 years, one and a half tablets (0.75 gm.) daily in half-tablet (0.25 gm.) doses at four-hour intervals; and for children 5-10 years, one tablet (0.5 gm.) daily, given in two half-tablet (0.25 gm.) doses, separated by four-hour intervals.

It was found that the rapidity with which individual patients react to treatment varies within wide limits. For this reason the aforementioned schemes of dosage were not followed rigidly in all cases, but were regarded as tentative systems which could be modified according to the clinical progress in individual cases. Better results are undoubtedly obtained in this way than by the adoption of a standard routine treatment for all cases.

Toxic symptoms have been almost negligible; nausea occurred in a few instances but disappeared when the treatment was stopped; toxic skin manifestations were seen once, in a European patient, but not in the Sudanese. Routine blood examinations were not carried out.

Sulphonamide therapy in complicated trachoma

By complicated trachoma we mean trachoma complicated by some other affection of the conjunctiva. In the present observations, pathological rarities are excluded, and the only superimposed conditions which need be considered are secondary bacterial infection and the so-called spring catarrh or vernal conjunctivitis.[4] According to Wilson,[5] trachoma in Egypt is essentially a chronic disease which generally commences and often progresses so insidiously that the patient is unaware of his infection. This is true in the Sudan also. In the vast majority of our cases, the patients present themselves at hospital only when the trachoma has become complicated by secondary infection, and when the latter clears up regard themselves as cured, and cease to attend for further treatment.

Secondary bacterial infection. In cases of trachoma complicated by secondary infection, it is rarely necessary in the Sudan to use cultural methods to identify the causal bacteria, since this can generally be done more rapidly by the examination of stained smears from the conjunctival exudate. The type and frequency of the bacteria concerned in a series of 200 such cases treated by sulphonamides was shown to be: gonococcus, 18.5 percent; Koch-Weeks, 65.5 percent; pneumococcus, 2 percent; Morax-Axenfeld, 14 percent.

It may be pointed out here that the discovery of a particular organism in the conjunctiva does not necessarily justify the conclusion that this is the cause of any pathologic condition which may be present. A number of the cases in the present group could be described clinically as "flare-up trachoma" rather than trachoma complicated by purulent ophthalmia. Since organisms were readily found in these cases, and the reaction to sulphonamides was similar to that of the purulent ophthalmias, we have not differentiated between the two conditions.

Sulphonamide therapy has a rapid curative effect in cases of trachoma complicated by secondary infection. This conclusion is derived from the observation of over 200 cases, previous cases being used as a control. In the past, treatment

in such cases was by irrigations with oxycyanide of mercury (1 :5,000 to 1 :10,000), combined with silver nitrate (1 percent), used either as drops or by painting, and atropine (1 percent ointment or drops), in the early and acute stages before the routine painting of the lids. This treatment was undoubtedly beneficial, and alleviated the symptoms in those cases in which there was little corneal involvement. If the cornea was involved, however, even hospitalization with three to four daily treatments did not prevent perforation and its sequelae in a large proportion of cases, especially those in which the gonococcus was implicated. With the introduction of sulphonamide therapy we did not discard local treatment in cases complicated by secondary infection, but continued this as before. Our primary object, it may be recalled, was to cure these patients, the collection of statistical data for publication being of secondary importance only. We believe that the irrigation has a beneficial effect on the mucopurulent discharge, no matter what other treatment is adopted, and the atropine is indicated as a routine on account of the frequent iritic involvement in these cases. With the addition of sulphonamide therapy to the treatment a much more rapid response was evident. This was particularly noticeable in a few very chronic cases in which improvement occurred suddenly after prolonged periods of treatment by other methods with no improvement. In the more acute cases perforation was now seen only occasionally, and its occurrence was restricted to individuals who did not come to hospital until the condition had become well established and perforation was already imminent. Even in cases in which the cornea did perforate, the sequelae were not so severe if the treatment included sulphonamides.

Numerous workers have recorded that sulphonamides are highly efficacious in the septic ophthalmias.[6, 7, 8] It is not surprising, therefore, to find that it produces a decided clinical improvement in cases of trachoma complicated by bacterial infection; this would result from alleviation of the latter condition alone. Yet clinically we find that in such cases sulphonamide therapy produces in addition improvement of the trachoma. This usually takes the form of a fairly rapid transition to the stages described as Tr iv[9] or Tr Q.[10] It is impossible from mere clinical observation to determine the mechanism by which this improvement is effected. It may result from a direct action of the drug on the trachoma, but the possibility cannot be excluded that severe secondary infection may, if recovery takes place, cause shedding of the epithelium with scarring, and thus produce an apparent cure of the trachoma.

Spring catarrh. In cases of trachoma complicated by spring catarrh no rapid improvement in the clinical condition is produced by sulphonamides. Our first series included 4 cases of this nature, and further observation of 15 cases indicates clearly that sulphonamides have no effect on spring catarrh. This is an entirely different type of complication from secondary bacterial infection. It has been regarded as an allergic condition[4, 11] but its etiology is at present obscure. We are unable to record any definite improvement of the trachoma in these cases.

Keratitis and pannus

These conditions are considered separately because their etiology is somewhat uncertain. There has always been some doubt as to whether pannus and keratitis were caused by trachoma *per se,* or whether they were the result of secondary infection. Prior to the introduction of sulphonamide therapy the orthodox view was that pannus was not due to secondary infection but was an integral part of the disease.[9]

However that may be, it is in cases of trachoma with such corneal complications as pannus and keratitis that the most satisfactory results are produced by the use of sulphonamides, both subjectively and objectively. Our first series included nine such cases, in eight of which a very rapid and dramatic improvement was observed, and observations continued during the past two years indicate clearly that this is the type of case in which sulphonamide therapy gives best results. Moreover, perusal of the literature at our disposal in Khartoum indicates that the majority of observers in other countries are in agreement with us on this point; for example, Wilson[12] in Egypt, Lian[1] in the Netherlands East Indies, Loe,[2] Gradle,[13] Richards *et al.*,[14] and Hirschfelder[15] in America, Lugossy[16] in Europe, and Hatschek[17] in Iraq. Burnet, Cuénod, Nataf, and Roussel[18] have recorded similar results from Tunis with allied compounds; namely, 4:4′ diamidino-diphenyl-sulphone glucoside[19] and "compound 33"—potassium or sodium salt of parasulphamidophenol—azosalicylic acid.[20] Our own observations have little to add to the descriptions already published of the course in such cases under sulphonamide therapy. Briefly, three stages may be described:

(1) The rapid alleviation of the more immediate subjective symptoms, such as pain, lacrimation, photophobia. This usually occurs within a few days.

(2) Resolution of the corneal lesions. This is usually a matter of a few (1 to 4) weeks. The rapidity with which pannus and keratitis may disappear is often remarkable. In mild or early cases the cornea may become perfectly clear. In the more severe cases some haziness may be left, depending on the amount and distribution of the resulting scar tissue; but since the amount of scar tissue deposited depends largely on the duration and severity of the corneal lesions, it is reasonable to believe that with a method of treatment which promotes such rapid resolution the formation of scar tissue will be reduced to a minimum. If the cornea is already opaque as the result of previous sclerosis, this, of course, does not disappear during treatment.

With the resolution of the corneal lesions there is usually a striking improvement in visual acuity, which may alter completely the patient's outlook on life.

(3) Improvement of the lids. Exuberant fleshy granulations on the lids tend to disappear fairly rapidly with the corneal improvement. Complete disappearance of the follicular hypertrophy is another matter. In our experience this is very variable; when it does occur the condition passes into stage Tr iv, but some cases appear to be particularly resistant and reach instead a stage resembling subclinical trachoma, after which treatment seems to have little effect. These cases are practically impossible to follow up properly. After the initial improvement in vision and disappearance of the subjective symptoms the patients rapidly tire of prolonged treatment which, in their opinion, is producing no further improvement, and cease to attend.

Pannus and keratitis are often associated with considerable discomfort, and, owing to the permanent damage to vision that they may produce, rank among the most formidable complications of trachoma. In these conditions sulphonamide therapy is infinitely preferable to the prolonged and exceedingly painful methods of treatment previously used.

Subclinical trachoma

This is a term used locally to designate trachoma in the Sudanese that causes no subjective symptoms, in which vision is unaffected, and which as a rule is only discovered by routine school, military, and other medical examinations. The occurrence of such a condition in the Sudanese

suggests that in this race trachoma *per se* is not necessarily a dangerous disease, but its potential danger is due to the diseased eye, being less resistant, becoming secondarily infected.

Except for the aforementioned routine examinations we do not see much subclinical trachoma. A series of 15 such cases was treated by sulphonamide, and for comparison a parallel series of 5 cases treated by the routine methods described by McKelvie[21] was selected for observation over the same period. Practically no change in the trachoma could be recorded in either series over a period of four months.

This is in agreement with the findings of Wilson[22] in Egypt, who treated with prontosil rubrum 10 children with primary trachoma, and concluded that the drug had no effect on the disease. These cases were seen by one of us (A. R. M.) four months after the commencement of treatment, and they were still undoubtedly cases of Tr i to Tr ii a. Later, Dr. Wilson in a personal communication stated he had used other sulphonamide compounds, with improvement in the congestion, and marked improvement in the pannus cases, but in stage Tr i to stage Tr ii a there did not seem to be much improvement. Some of these latter cases were also seen by one of us (A. R. M.), who agreed with Dr. Wilson as to the condition present in every case.

The opinions of American workers are divided with regard to the effect of sulphonamides in primary uncomplicated trachoma, but caution is required in the interpretation of the results of different observers. It is uncertain whether the terms used to describe the type of disease are exactly synonymous in all cases, or whether any of the conditions described correspond exactly with subclinical trachoma as observed in the Sudanese. Some of the results, however, are of considerable interest. On the White Mountain Apache Indian Reservation, Forster[23] found that "the effect of sulphanilamide therapy on early (stage i) trachoma was very striking. Frequently both cornea and conjunctiva returned to normal within the first 10 days." Thygeson[24] notes that the most rapid response was obtained in cases in which there was no secondary bacterial infection. On the othe hand, in the Southern Illinois Trachoma Clinics, Hirschfelder[15] found no definite improvement after two weeks in children "who had no, or only very slight subjective symptoms, and normal vision," although improvement was noted in other varieties of the disease. Spinning[25] records only "slight to moderate improvement" in a series of children with chronic trachoma and little or no bulbar or corneal involvement other than slight pannus. Julianelle, Lane, and Whitted[26] conclude that "in uncomplicated trachoma, improvement measured by numerical reduction, flattenning, and blanching of the follicles is common but genuine recovery is infrequent."

The causal agent of trachoma

Gradle[13] has described the clearing of the cornea and disappearance of the conjunctival follicles in cases of trachoma in which the existence of secondary bacterial infection was excluded by the most exacting methods available; namely by daily cultures taken from the conjunctiva. MacCallan,[27] on the other hand, maintains that the beneficial effects produced by sulphonamides are entirely due to the elimination of secondary infection, and that the drug has no effect whatever on trachoma.

In the opinion of the present writers it is difficult to see how this vexed question can be satisfactorily settled until it is possible to isolate the causal agent of trachoma and study it experimentally. At the present time it has not even been identified with certainty. From time to time claims have been put forward incriminat-

ing one or other of the various bacteria that can be isolated from the conjunctiva, but these have all been discredited for lack of satisfactory evidence. Attention is directed at present to the intracellular bodies described many years ago by Halberstaedter and von Prowazek[28] and now generally known as the Halberstaedter-Prowazek or H.P. bodies. Although definite proof is still lacking, these bodies are now generally regarded as the causal agent of trachoma.[29] Morphologically similar bodies are found in three other diseases; namely, in psittacosis,[30] lymphogranuloma inguinale,[31] and inclusion blennorrhea.[32] It would appear that with trachoma these three conditions form a special group of virus diseases, distinguished by the fact that the virus apparently goes through an elaborate life cycle that can be observed microscopically.

MacCallum and Findlay[33] have shown that sulphonamides can protect mice against the fatal meningoencephalitis that normally follows intracerebral inoculation of the virus of lymphogranuloma inguinale. Similar results have been recorded by Bär[34] and Levaditi,[35] while in the human subject, the drug has been found clinically effective by Gjuric,[36] Kubitzki,[37] and other workers. It was the morphological similarity between the inclusion bodies of lymphogranuloma[31] and the H.P. bodies of trachoma[38] which originally induced the present writers, on the suggestion of Dr. Findlay, to test the effects of sulphonamides in trachoma. In this connection it is of particular interest to note that good results have also been obtained clinically in inclusion blennorrhea with sulphonamide therapy by McKelvie,[39] Thygeson,[40] and other workers. As far as we are aware, no clinical or experimental work has been published describing the effects of sulphonamides in psittacosis, but observations on this point are awaited with some interest.

Effects of sulphanilamide on the H.P. bodies

Julianelle, Lane, and Whitted[26] in America, and Burnet, Cuénod, Nataf, and Roussel[18] in Tunis state that one of the effects of sulphonamide is to cause the disappearance of the H.P. bodies from the conjunctival epithelium. Similar findings are reported by Richards, Forster, and Thygeson,[14] who found in addition that the pooled epithelial scrapings taken on the tweny-ninth day from treated patients failed to infect baboons.

In the Sudan it has not been possible to confirm these findings, nor indeed to reach any satisfactory conclusion on this point. It may be noted that the facility with which the H.P. bodies can be demonstrated seems to vary under different conditions, and that their presence is not necessarily associated with active trachoma. Thus Wilson[41] in Egypt found H.P. bodies in 100 percent of children examined shortly after birth and before clinical trachoma had developed, while at older ages the percentage of positives was much less. A table published by Thygeson and Richards[42] indicates how the percentage of positive findings varies with the stage of the disease in various localities. In the Sudan no figures referring to newly born children are available to compare with those of Wilson. In older children or adults with recognizable trachoma the proportion of positive findings is rarely as high as 25 percent in stages Tr i to Tr ii, and under 1 percent in stages Tr iii.

An attempt has been made to observe the effects of sulphonamides on the H.P. bodies in a series of 20 cases in which the bodies were readily found at the commencement of treatment. The results are as follows:

Eleven of the patients discontinued treatment as soon as an initial improvement occurred, but before the trachoma

had reached a satisfactory clinical condition in which negative scrapings could reasonably be expected. One of these is of some interest. His condition was recorded on January 8, 1939, as Tr ii to Tr iii, smears positive for H.P. bodies. He was given a course of 28 gm. of sulphonamide over a period of 14 days, with considerable improvement. On January 21, 1939, his condition was recorded as follows: L.E. Tr iii to Q, one or two follicles on tarsus, slide positive for H.P. bodies; R.E. Tr Q., slide negative for H.P. bodies. The patient went away on this date, and has not been seen since.

The eyes in three cases were still found positive after treatment had been concluded, and the trachoma had apparently resolved successfully. The patients have not been seen again, so that a follow up has not been possible to determine whether the H.P. bodies disappeared later, or whether relapse took place.

In the remaining six cases the eyes became negative after treatment of varying duration, with apparent cure of the trachoma. Three of these cases were not seen again, but in the other three, positive symptoms were found once more, 14, 21, and 74 days later.

Owing to the small proportion of cases in which H.P. bodies can be found before treatment, negative results after treatment have very doubtful statistical significance in such a small number of cases. Much more significance attaches to the few cases in which the eyes were still positive after treatment, or after becoming negative, were later found to be positive. Those few cases indicate that the remarkable clinical amelioration produced by sulphonamides in trachoma is not necessarily associated with the immediate disappearance of the H.P. bodies.

It is doubtful how much significance can be attached to this observation. The persistence or disappearance of the H.P. bodies is probably of no importance as an indication whether the sulphonamides act directly on trachoma or not. The only comparable infection that can be studied under experimental conditions is lymphogranuloma inguinale. MacCallum and Findlay[38] found that sulphonamides were able to protect mice against this infection, which is normally fatal in these animals, but virus bodies were found in the tissues of the treated mice which survived, as well as in the untreated controls, which died. Moreover, in psittacosis it has been shown by Bedson[43] that the virus may persist in the tissues for long periods after natural recovery from the disease, and according to Olitsky and Long[44] this occurs also in a number of other virus infections.

Summary and conclusions

To sum up, sulphonamide therapy has little or no effect in certain cases of trachoma; it produces a variable degree of improvement in others; while in some instances it effects a rapid and very dramatic clinical improvement. In the cases in which it is most effective sulphonamide therapy is from the patient's point of view infinitely preferable to any other form of treatment that has been used, although it may often with advantage be combined with other forms of treatment.

We have tried to indicate the types of the disease as observed in the Sudan that derive benefit from the drug and those in which the benefit is slight or doubtful, since it is evident from the literature that there is some divergence of opinion on this point among workers in different places. In general terms it may be said that the effects of sulphonamide therapy in trachoma are most dramatic in those cases in which the disease has produced serious clinical manifestations—that is to say, in just those cases in which an effective therapeutic agent is required—whereas in

subclinical trachoma, in which vision is unaffected, in which the patient has no subjective symptoms and the condition is discovered only by careful clinical examination, sulphonamides appear to have little or no effect. This at least is what we have observed in the Sudan, among a population in which the infection may possibly have been endemic for centuries; it does not follow that these conclusions are applicable in other parts of the world. Moreover our observations (which are here at variance with those of several workers elsewhere) indicate that the rapid clinical improvement induced in the former type of case is not necessarily associated with the immediate disappearance of the H.P. bodies.

The action may be summarized in purely descriptive terms by saying that sulphonamide therapy, without eliminating the infection, enables individuals in whom the infection is pathogenic to deal with it as if it were nonpathogenic. In subclinical trachoma the infection is already nonpathogenic, or only mildly pathogenic, so that the effect of sulphonamide therapy is not so dramatic. This is comparable to the effect observed by MacCallum and Findlay[33] in experimental lymphogranuloma infections; and Browning[45] has recently described in somewhat similar terms the effects of sulphanilamide in streptococcal infections.

It may be emphasized that this conception is purely descriptive and does not explain how the observed effects are produced. MacCallan[27] has attempted to explain it on the assumption that the sulphonamides have no action whatever on trachoma, and the beneficial results observed clinically are entirely due to the effect of the drug on superimposed bacterial infection. This would imply that pannus, keratitis, and the like, indeed all the serious clinical manifestations which react to sulphonamides, are the result of secondary infection, and that trachoma itself is a nonpathogenic or only mildly pathogenic infection of no clinical importance. All the observations recorded in the present paper are quite consistent with this hypothesis, but it is doubtful whether many workers elsewhere will accept this view of trachoma without more conclusive evidence. Probably this question will not be satisfactorily settled until the causal agent of trachoma can be isolated, or at least studied under experimental conditions, like the virus of lymphogranuloma inguinale.

References

[1] Lian, B. Prontosil therapie bij trachoom. Geneesk. Tijdschr. Nederl-Indië, 1938, v. 58, p. 1058.

[2] Loe, F. Sulphanilamide treatment of trachoma: Preliminary report. Jour. Amer. Med. Assoc., 1938, v. 111, p. 1371.

[3] Kirk, R., McKelvie, A. R., and Hussein, H. A. Sulphanilamide in the treatment of trachoma. Lancet, London, 1938, v. 2, p. 994.

[4] Leberfeld, L., and Miller, J. Additional research on vernal conjunctivitis. Archiv. of Ophth., 1939, v. 21, p. 639.

[5] Wilson, R. P. Ophthalmia Aegyptica. Amer. Jour. Ophth., 1932, v. 15, p. 397.

[6] Glover, L. P. Some uses of sulphanilamide in ophthalmology. Amer. Jour. Ophth., 1939, v. 22, p. 180.

[7] Guyton, J. S. The use of sulphanilamide compounds in ophthalmology. Amer. Jour. Ophth., 1939, v. 22, p. 833.

[8] Barbour, F. A., and Towsley, H. A. Experience with sulphanilamide in treatment of gonorrheal ophthalmia. Arch. of Ophth., 1939, v. 22, p. 581.

[9] MacCallan, F. W. Trachoma. London, Butterworth & Co., 1936.

[10] Kirk, R., McKelvie, A. R., and Drysdale, A. D. The Weil-Felix reaction in trachoma. Jour. Hygiene, 1939, v. 39, p. 553.

[11] Lyons, F. M. Observations on the pathogenesis of spring catarrh. Annual Report Mem. Ophth. Lab. Giza, 1936, v. 11, p. 121.

[22] Wilson, R. P. Personal communication.
[23] Gradle, H. S. Arch. of Ophth., 1939, v. 20, p. 881 (in discussion).
[24] Richards, P., Forster, W. G., and Thygeson, P. Treatment of trachoma with sulphanilamide. Arch. of Ophth., 1939, v. 21, p. 577.
[25] Hirschfelder, M. Treatment of trachoma with sulphanilamide. Amer. Jour. Ophth., 1939, v. 22, p. 299.
[26] Lugossy, G. The problem of chemotherapy in trachoma. Abst. in Amer. Jour. Ophth., 1940, v. 23, p. 583.
[27] Hatschek, G. Cited by Burnet, E., Cuénod, A., Nataf, R., and Roussel, H. See reference 18.
[28] Burnet, E., Cuénod, A., Nataf, R., and Roussel, H. Traitement chronique du trachome. Arch. Inst. Pasteur de Tunis, 1940, v. 29, p. 66.
[29] Buttle, G. H. A., Dewing, T., Foster, G. E., Gray, W. H., Smith, S., and Stephenson, D. Biochem. Jour., 1938. Cited by MacCallum and Findlay (ref. 33).
[30] Gossidet, P., Despois, R., Gailliot, P., and Mayer, R. De l'action du radical sulphamide $So_2 NH_2$ sen l'infection streptococcique expérimentale de la souris. Compt. Rend Soc. de Biol., 1936, v. 121, p. 1082.
[31] McKelvie, A. R. Ophthalmic report. Report of the Sudan Medical Service 1936, p. 67.
[32] Wilson, R. P. Ann. Rep. Mem. Ophth. Lab. Giza, 1938, v. 12, p. 103.
[33] Forster, W. G. Treatment of trachoma with sulphanilamide. Amer. Jour. Ophth., 1940, v. 23, p. 532.
[34] Thygeson, P. Treatment of trachoma with sulphanilamide. Arch. of Ophth., 1939, v. 22, p. 923.
[35] Spinning, W. D. Use of sulphanilamide in trachoma. Amer. Jour. Ophth., 1940, v. 23, p. 271.
[36] Julianelle, L. A., Lane, J. F., and Whitted, W. P. The effect of sulphanilamide on the course of trachoma. Amer. Jour. Ophth., 1939, v. 22, p. 1244.
[37] MacCallan, A. F. Sulphonamide treatment of bacterial and trachomatous conjunctivitis. Brit. Med. Jour., 1940, v. 1, p. 482.
[38] Halberstaedter, L., and von Prowazek, S. Ueber Zelleinschlüsse parasitärer Natur beim Trachom. Arb. a.d.k. Gsndhtsamte, 1907, v. 26, p. 43.
[39] Julianelle, L. A. The etiology of trachoma. New York, The Commonwealth Fund, 1938.
[40] Bedson, S. P., and Bland, J. O. W. The developmental forms of psittacosis virus. Brit. Jour. Exper. Path., 1934, v. 15, p. 243.
[41] Findlay, G. M., Mackenzie, R. D., and MacCallum, F. O. A morphological study on the virus of lymphogranuloma inguinale. Trans. Roy. Soc. Trop. Med. and Hyg., 1938, v. 32, p. 183.
[42] Julianelle, L. A., and Lange, A. C. Studies on inclusion blennorrhea. Amer. Jour. Ophth., 1938, v. 21, p. 890.
[43] MacCallum, F. O., and Findlay, G. M. Chemotherapeutic experiments with the virus of lymphogranuloma inguinale in the mouse. Lancet, 1938, v. 2, p. 136 (also personal communication from Dr. Findlay).
[44] Bär, F. Chemotherapeutische Versuche bei der experimentellen Infektion der Maus mit Lymphogranuloma inguinale. Klin. Woch., 1938, v. 17, p. 588.
[45] Levaditi, C. Chimiothérapie de la lymphogranulomatose inguinale experimentale. Compt. Rend. Soc. de Biol., 1938, v. 128, p. 138.
[46] Gjuric, J. Neue Wege in der Behandlung des Lymphogranuloma inguinale. Münch. Med. Woch., 1938, v. 85, p. 335.
[47] Kubitzki. Beitrag zur Behandlung lokaler und allgemeiner Infektionen und des Lymphogranuloma inguinale mit Prontosil. Deutsche mil.-ärztl. Zeit., 1938, v. 3, p. 116.
[48] Foley, H., and Parrot, L. Rickettsia du trachome. Arch. Inst. Pasteur d'Algérie, 1937, v. 15, p. 339.
[49] McKelvie, A. R. Ophthalmic report. Annual Rep. of the Sudan Medical Service, 1938, p. 67.
[50] Thygeson, P. Sulphanilamide in inclusion conjunctivitis. Amer. Jour. Ophth., 1939, v. 22, p. 179.
[51] Wilson, R. P. 11th Annual Rep. Mem. Ophth. Lab. Giza, 1937, pp. 113 and 117.
[52] Thygeson, P., and Richards, P. Nature of the filterable agent of trachoma. Arch. of Ophth., 1938, v. 20, p. 569.
[53] Bedson, S. P. A study of experimental immunity to the virus of psittacosis in the mouse, with special reference to the persistence of infection. Brit. Jour. Exper. Path., 1938, v. 19, p. 353.
[54] Olitsky, P. K., and Long, P. H. Relation of vaccinal immunity to the persistence of the virus in rabbits. Jour. Exper. Med., 1929, v. 50, p. 263.
[55] Browning, C. H. The present position of chemotherapy by drugs of the sulphanilamide group. Brit. Med. Jour., 1939, v. 2, p. 265.

CONVERGENCE INSUFFICIENCY*

BEULAH CUSHMAN, M.D., AND CLARA BURRI, PH.D.
Chicago

Data on 80 patients with convergence insufficiency who were examined in the private practice of one of us (B. C.) during the past two years form the basis of this report. The patients received complete ophthalmologic examination including cycloplegic refraction and muscle tests. The routine examination included determination of the visual acuity of each eye, muscle balance with the Maddox rod for near and distance, the near point of accommodation of each eye, the near point of convergence, and the ductions. After a diagnosis was made, and glasses were prescribed if needed, the patients were referred to the other of us (C. B.), who checked again their phorias with the screen and parallax test in the primary and the six cardinal directions, also the ductions, fusion, and stereoscopic ability, and conducted the orthoptic training. In case of reading difficulty, reading analysis and guidance were instituted.

As a rule patients with convergence insufficiences are those who complain of "eyestrain," who are unable to continue near work for any length of time, and to whom glasses do not afford complete relief. Many of the patients showed relatively low refractive errors, others did not require glasses, while several had high refractive errors. In spite of a low refractive error some of these patients had had their glasses changed frequently. Some had worn from one to two degrees of prism, base in. Others had had prism and stereoptic exercises at home with apparently little or only temporary relief. Among this group we find patients who come to the ophthalmologist's office with several pairs of glasses or a handful of prescriptions. Since frequently their refractive error is small and their exophoria apparently negligible, after having tried glasses without relief, they are often dismissed as neurotic.

We define convergence insufficiency as outward cover deviation at the near point, or when the deviation is larger at the near point than for distance. Mann[1] in a recent article stated that the most characteristic finding in convergence insufficiency is the inability of the patients to perform voluntary convergence easily, even when it is explained to them, and when there is a deviation of more than 6 degrees outwards with the Maddox-Wing test. However, in our group of patients we found that any numerical statements of the amount of exophoria was misleading; in fact, it was far better to use the patient's comfort or lack of comfort in deciding whether or not they should receive orthoptic training. Whether a patient had 6 degrees of exophoria or more or less was of minor importance; it was the relationship between the abduction and adduction reserve that determined whether or not comfortable vision was possible for near. The eyes, like other organs, show considerable plasticity and capacity for adjustment. The degree of this ability may vary from individual to individual, and even in the same individual from time to time. After all, the primary purpose is to obtain clear and comfortable macular vision. As long as the neuromuscular mechanism of the eyes is able to obtain this goal by integrating in such a way as to maintain clear binocular vision under all ordinary conditions, and with the least expenditure of energy,

* Read before the Chicago Ophthalmological Society, December 16, 1940.

the eyes will perform their task quite unconsciously and without causing discomfort. As soon as there exists poor integration then various symptoms such as "eyestrain," burning sensation, fatigue, and headaches are experienced. The orthoptic exercises do not always eliminate the phoria, but do increase the ductional reserve so that the patient is better able to cope with the existing phoria. In this group we have thus included only patients who had good fusion and stereoscopic vision, but who had weak ductions. They may or may not have an exophoria under cover.

Mann[1] referred to the final and highest form of binocular vision as arising when by voluntary muscular action the fields of vision can be overlapped to obtain stereoscopic vision at the near point, and voluntary control of convergence. Voluntary control is dependent on the existence of cortical connections whereby the lower centers are linked with the association areas controlling such movements. How this takes place is still somewhat problematical, but in his paper "The cerebral integration of the ocular movements," Gordon Holmes[2] states one view; namely, that in the cerebral integration of ocular movements two widely separated cortical areas are involved, the frontal and occipital, and that each has its own projection tract to the oculomotor mechanism in the brain stem. He maintains that there must be a visual factor with a tendency to keep the images of the object at which the subject looks on the fovea, either by maintaining fixation or the posture of the eyes, or by moving them. Fixation, then, is the maintenance of posture of the eyes by tonic contraction of the ocular muscles so that the retinal images of the object which is fixed fall on the two foveas.

Although exact localization of function has not been proved, there seems to be some evidence to indicate that localization is associated with a considerable amount of plasticity. For example, even the simplest afferent impulse may produce general activity of the cortex, while in other conditions certain reactions are definitely located. Beever and Horsley apparently found the center for eye movement in the frontal lobes. In addition to this center there seems to be another in the occipital lobe close to the area striata. According to Gordon Holmes, the frontal area governs voluntary control and the occipital area the fixation reflex. If the frontal area is destroyed the patient cannot look voluntarily toward a certain direction, but he can follow a moving object; while if the center in the occipital area seems to be destroyed the patient cannot fixate but can voluntarily move the eyes. Accordingly, in an act of looking on an object, or in reading, a high degree of integration is required, and if the function is hindered by some sort of inhibition or lack of development in any given part of this neural configuration of the visio-motor control, then symptoms will occur. These symptoms probably do not appear until the individual's organism as a whole, or the visio-motor mechanism in particular, is no longer able to compensate or adjust the visual integration in such a way that clear binocular vision is obtained. Or, if such failure should be due to an abnormal accommodative and convergence relationship, or to lack of development or maturity of any part of the visio-motor pattern, the individual will be unable accurately to perform the task of seeing clearly at the near point. Only then will the patient have any subjective signs.

Now if we can assume that voluntary convergence, fusion, and stereopsis are at least partially controlled by the frontal lobe, and if we assume that this control can be learned or improved at any period of life, then we may also assume that binocular vision and motor integration are

not fully established at birth, but develop gradually throughout the first months or years of life. Accordingly, if the child is forced to do much near work before normal binocular integration is developed, phorias may occur or even squints, and in some cases the individual may never acquire proper voluntary control of binocular vision.

No definite experimental evidence exists to show the exact developmental process of binocular vision. Gesell,[3] in his developmental studies of infants, found the fixation movement to occur after the age of six months, while binocular fixation occurred still later. Mann reports, from a study of a series of children, that normal fusion and stereopsis are generally not fully developed until the age of six years, and that this may be even longer delayed. If so, and if the child is forced to do much close work, as often happens in the case of highly intelligent children, or overly ambitious parents, bad binocular habits of convergence are established, and symptoms may occur at an early age. However, it may also happen that, in spite of poor binocular habits, the individual will get along without symptoms until some later period in life, and again some persons may never experience any trouble. Probably many other factors contribute toward a final break down, such as general ill health with vitamin deficiencies and low muscle tonus, prolonged near use of the eyes, presbyopia, poorly fitted glasses, glandular disturbance, psychological complications, and maladjustments.

This would account for the fact that symptoms from convergence insufficiency occur at any age, and that some go through life without ever experiencing any trouble, especially if their work does not demand continued near work.

In some of our cases glandular disturbances were discovered which were treated by the internist; and a few mild vitamin-B deficiencies were treated with improvement of the muscle imbalance.

Psychological interpretation and guidance were of great value in the three definite instances of reading difficulties and in some of the adults who continued to have vague symptoms, which were probably of psychologic origin, even after the ductions were within normal limits. Some adults showed very marked neurotic tendencies, but whether they were the result of ocular difficulty, or of a general maladjustment, it was difficult to determine; however, help in solving their personal problems reacted favorably upon the progress of the ocular relief during training. These are the people who may report recurrence of their eye symptoms, since they frequently refer their neurotic complex to the eyes. Unless they learn to solve their personal problems they will retain their eye discomforts.

Children who are urged to do minute work before normal fusion and convergence are developed may also develop psychologic manifestations. This is especially true in cases of only a low refractive error when nothing is done to overcome the existing lack of integration. These children, when urged to do much close work, develop nervousness and irritability, and later because of their inability to cope with the requirements put upon their eyes during the process of learning to read, develop reading difficulties. In addition, the anxiety aroused in them as the result of criticism from teachers and parents and their own knowledge of their failure in learning to read only increase the psychologic problems and the ocular discomfort. That is why the objective factors, such as the phorias and weakness of convergence, may exist without any symptoms; in some cases even the development of the ductional reserve does not eliminate all complaints. It is important to remember the complexity of the

problem in the management, training, and prognosis.

The pinpoint exercises and the rotoscope have been the mechanical aids used in the development of good binocular vision and convergence.

Lately a copy of directions for convergence exercises as outlined by Mann has been used to encourage convergence.

Training to increase the ability to fixate and fuse in the parallel position was first given, and gradually the amount of prism, base out, increased until the patient learned to converge easily at the reading distance. Adduction training was given for the distance and near position on the rotoscope. As a rule the patients progressed evenly without much difficulty; however, there were some patients who did not progress beyond a certain point in the development of the abduction-adduction balance. In these cases weak pilocarpine (0.25 percent) was used every morning to stimulate accommodation and reflexively, the convergence, and weak homatropine (0.5 percent) was used in these cases in which there were mild accommodative spasms. The effect of the drugs on the size of the pupil and indirectly on the intraocular muscles carried these patients over the block, and finally a satisfactory muscle balance was obtained.

Results

The results of our own investigation are demonstrated in the following tables.

TABLE 1

Frequency of cover deviation

Type of Deviation	Total Group	Males	Females
Near and distance	23	8	15
Near only	39	19	20
No Deviation	18	9	9
Total	80	36	44

In a general way they are self-explanatory.

TABLE 2

Type of Difficulty

Type of Difficulty	Total Group	Males	Females
Fusion and stereopsis	0	0	0
Phoria (exophoria)	63	28	35
Adduction weakness	69	29	40
Abduction and adduction weakness	11	7	4

Table 1 shows the number of patients who had a cover deviation; 23 of the 80 patients had an exophoria for near and distance, 39 for near only, and 18 were orthophoric as measured with the cover test.

In table 2, the type of difficulty is shown. All patients had fusion and stereopsis. With the first exercises using pictures requiring macular perception, some patients showed a tendency to alternating fixation, and it was only after a number of exercises that good binocular fixation was well maintained. Sixty-nine patients had adduction weakness and 11 abduction and adduction weakness. Of the 80 patients, 63 had exophoria for either near alone or near and distance, while the remaining 17 had only duction weakness, either adduction alone or with abduction weakness. If there was an exophoria for distance it was always smaller than the one for near.

TABLE 3

Use of glasses

Frequency of Use	Total Group	Males	Females
Constantly	34	14	20
Intermittent	12	5	7
No glasses	34	17	17
Total	80	36	44

Table 3 gives the use of glasses. Glasses were worn constantly by 34 patients, intermittent use was required by 12, and no glasses were found necessary in 34 cases. Of the 34 persons who did not use glasses, only one was actually emmetropic,

but the others had only very small refractive errors, and these were comfortable without glasses after the ductions became more nearly balanced.

TABLE 4

RECOVERY FROM SYMPTOMS OF VARIOUS GROUPS

Type of Patients	Number of Patients Recovered	Percent Recovered
Without cover deviation	16 of 18	94
Exophoria, near only	25 of 39	66
Exophoria, near and distance	12 of 25	52
Total group	53	66

Table 4 shows the percentage of recovery among the various types of patients. It includes only those who finished the exercises, many of those who discontinued treatment were becoming comfortable.

In a more careful analysis we find that the patients without cover deviation recovered more promptly. Sixteen of 18 recovered after an average of 11 exercises. Of those with exophoria for near, only 25 of 39 recovered after an average of 17.12 treatments. Of those with exophoria for near and distance, 12 of 25 recovered after an average of 16.35 treatments. Therefore, of the whole group 53 of the 80 patients recovered satisfactorily after an average of 16.3 treatments. In analyzing the data in regard to the remaining 27 who did not recover, we find that one had a complicating blepharitis, six had associated glandular insufficiencies, one pernicious anemia, one went away to school, one left the city, one was unable to continue, two are continuing with their exercises, and nine dropped out.

In table 5 we analyzed the degree of recovery for the group as a whole and for males and females separately. Of the total group, 53 patients recovered from all symptoms, 24 showed improvement but not complete recovery, while 3 showed no change. Of the last group, two were patients with marked neurotic tendencies, and may have referred their symptoms to their eyes. One of these patients had marked psychological symptoms due to menopausal disturbance, the third had pernicious anemia.

TABLE 5

TOTAL RECOVERY FROM SYMPTOMS

Degree of Recovery	Total Group	Males	Females
Complete Recovery	53	23	30
Improved	24	12	12
No change	3	1	2
Total	80	36	44

By recovery from symptoms, the subjective symptoms are meant, not the objective findings. In most of the cases the phoria remained unchanged, but the training established the increase of convergence and ductional relationships, enabling the patient to cope with his phoria without fatigue and eyestrain.

Table 6 shows the average number of exercises required for total recovery for various groups. This table is self-explana-

TABLE 6

AVERAGE NUMBER OF EXERCISES REQUIRED FOR TOTAL RECOVERY FOR VARIOUS GROUPS

Type of Group	Total Number in Group	Average for Total	Average for Males	Average for Females
Exophoria, near and distance	23	16.35	14.86	17.13
Exophoria, near only	39	17.12	14.26	20.40
Without exophoria	18	11.00	10.10	12.40
Group as a whole	80	16.36	15.50	18.45
Spread of number of exercises		2 to 47	2 to 42	2 to 47

TABLE 7

RECORD OF PATIENTS WITH COVER TEST NEGATIVE

Case	Sex	Age	Phoria Cover Test N.	Phoria Cover Test D.	Rotoscope Ductions abd.	Rotoscope Ductions add.	Gl C W N.	Pilocarpine	Number of Exercises	Ductions After Exercises abd.	Ductions After Exercises add.	Sy. Cu R N.	Remarks
8	F	11	0	0	8– 4	8– 5	N	no	14	10–8	45–20	Cu	hypothyroid
9	F	25	0	0	4– 2	5– 2	N	no	7	6–4	28–20	Cu	
10	M	37	0	0	5– 3	4– 2	C	yes	14	10–8	25–12	Cu	
14	M	28	0	0	5– 2	8– 4	N	no	6	8–5	24–16	Cu	
19	M	21	0	0	6– 4	5– 2	C	no	7	10–4	45–30	Cu	stutterer
26	M	39	0	0	8– 6	10– 5	C	yes	11	8–6	24–16	Cu	
28	F	32	0	0	8– 6	14–10	W	no	2	8–6	30–15	R	dropped out
36	M	43	0	0	10– 7	18–12	W	no	7	10–8	50–30	Cu	
43	F	13	0	0	6– 4	10– 5	N	no	13	8–4	35–20	Cu	sister same difficulty
46	M	13	0	0	7– 4	20–10	W	no	15	12–8	45–21	Cu	
48	M	48	0	0	14–10	16–14	C	no	13	10–8	40–30	Cu	
53	F	27	0	0	10– 8	10– 0	N	no	15	8–4	45–20	Cu	
54	F	27	0	0	8– 6	8– 0	C	yes	20	12–8	35–16	Cu	improved—vitamin B
57	M	31	0	0	6– 4	5– 0	N	no	15	18–6	40–20	Cu	
58	F	34	0	0	10– 8	4– 0	W	no	12	8–4	45–11	Cu	
33	M	25	0	0	10– 8	10– 5	C	no	3	10–8	30–10	R	dropped out
73	F	27	0	0	8– 2	12– 2	N	no	14	10–8	45–20	Cu	
78	F	34	0	0	10– 2	10– 2	C	no	10	8–2	36–12	Cu	

For explanation of symbols used in tables 7, 8, and 9 see text, p. 1049.

tory and nothing need be said except that the high average for the females of group "exophoria for near only" is due to two very difficult patients, one had an associated surgical menopause, the other refused to wear her glasses. Excluding these patients would bring the average within the limits of that for the group with "exophoria for near and distance." In general, one may say that there is little difference in the number of exercises needed when exophoria is present for near only, and when it is present for near and distance.

Tables 7, 8, and 9 give the data on each individual. The patients are divided into three groups according to the findings on the cover test. Merely a detailed representation of the total findings is given, showing the specific findings, the degree of development, and the number of exercises. The following abbreviations were used: Gl, glasses; C, constant; W, work; N, none and near; Sy, symptoms; Cu, cured; R, relieved; D, distance. Table 7 gives the patients who had no phorias but merely duction weakness, either adduction weakness alone or combined with abduction insufficiency. Table 8 gives the records of those patients with an exophoria for near only and duction weakness, and table 9 shows the records of patients with exophoria for near and distance plus duction weakness.

In table 10 we have attempted to give some idea of the permanence of recovery. Here we show the size of the ductions as obtained immediately after the completion of the exercises and also those taken on some later date. As may be noticed the objective measures remained fairly stationary, or at least within normal limits. This is true even in the case in which the two measurements were taken one year later. Most of these patients remained symptomless.

TABLE 8

RECORD OF PATIENTS WITH EXOPHORIA FOR NEAR ONLY

Case	Sex	Age	Cover Test N.	Cover Test D.	Rotoscope Ductions abd.	Rotoscope Ductions add.	Gl C W N	Pilocarpine	Number of Exercises	Ductions After Exercises abd.	Ductions After Exercises add.	Sy. Cu R N	Remarks
1	M	32	2	0	5– 0	16– 5	N	yes	20	10– 8	40–20	Cu	
2	F	36	4	0	10– 0	15–10	N	no	12	10– 6	45–20	Cu	
3	M	15	6	0	15–10	15– 5	W	yes	26	8– 4	45–30	Cu	
4	M	11	2	0	10– 8	15–10	N	no	8	12– 8	50–30	Cu	
6	M	46	4	0	5– 3	15–12	C	no	11	7– 5	35–12	R	
11	M	17	3	0	8– 6	8– 5	N	no	15	10– 8	50–30	Cu	
12	F	33	3	0	6– 4	18–16	N	no	21	7– 4	38–15	Cu	
13	M	29	4	0	10– 4	10– 4	N	yes	19	10– 8	50–30	Cu	
16	F	6	2	0	8– 6	22– 6	C	yes	19	14–10	35–15	Cu	reading difficulty
17	M	46	4	0	8– 4	14– 4	C	no	21	11– 6	50– 3	Cu	
18	M	17	4	0	4– 0	14–10	C	no	9	8– 4	40–20	Cu	
20	M	27	3	0	14– 8	20–18	C	yes	8	12– 8	50–40	R	complicated—infection
21	M	32	2	0	14–10	15– 4	N	no	11	15– 5	45–20	Cu	
22	F	38	3	0	9– 8	10– 5	N	no	39	8– 5	30–12	Cu	
23	F	27	2	0	9– 8	14–10	C	yes	37	14– 8	34– 5	Cu	low thyroid.
27	M	26	4	0	10– 8	24– 4	N	no	2	10– 8	20–	N	dropped out.
29	F	22	4	0	6– 2	10– 2	W	yes	13	6– 5	34–30	Cu	
30	F	18	2	0	5– 4	14– 0	N	no	12	6– 3	30–20	R	
34	F	17	7	0	12– 7	18– 2	W	no	15	10– 7	26–15	R	hypothyroid, dropped out
35	M	28	5	0	16–10	22–10	N	no	5	15–10	50– 4	R	dropped out
37	M	21	4	0	6– 4	4– 2	C	yes	42			Cu	had diplopia
38	M	22	2	0	8– 6	14– 8	N	no	10	10– 5	24– 9	R	went away to school
40	F	43	2	0	8– 4	2– 0	N	no	7	8– 4	22–10	R	dropped out
41	F	15	2	0	8– 4	2– 0	N	no	12	8– 4	30–16	Cu	
42	M	32	3	0	8– 4	4– 0	N	yes	28	10– 8	30–16	Cu	
45	M	30	4	0	10– 8	10– 5	N	no	4	10– 8	24–	R	dropped out
49	M	34	2	0	8– 6	5– 0	W	no	7	8– 6	34–16	Cu	
52	F	44	2	0	11– 8	20–10	C	no	12	10– 8	45–22	Cu	
56	F	46	6	0	18–14	4– 0	C	no	16	14–10	35–10	R	left city
59	F	41	4	0	14–10	18– 2	W	yes	44	10– 8	40–30	Cu	
63	F	33	2	0	4– 2	10– 2	C	yes	47	8– 2	36–24	Cu	surgical menopause
64	F	30	2	0	10– 3	20– 4	C	no	13	8– 3	35–15	Cu	
65	F	5	2	0	8– 4	0	N	no	17	8– 4	40– 5	R	improved after vit. B
66	F	16	4	0	8– 6	14– 5	N	no	30	5– 4	45–20	Cu	had much diplopia
68	M	17	5	0	10– 8	15– 5	C	no	10	10– 8	30–10	R	dropped out
70	F	27	3	0	10– 5	2– 0	C	yes	16	6– 4	40–16	Cu	
74	F	50	5	0	10– 8	4– 0	C	no	11	12– 2	30–12	R	still taking exercises
77	M	22	4	0	4– 0	2– 0	C	no	15	4– 2	20– 5	R	still taking exercises
79	F	24	4	0	10– 8	5– 0	N	no	15	10– 8	30–16	Cu	

The patients who had reading difficulty—as indicated by an asterisk—were given a complete psychologic examination in order to determine the specific reading problems. In addition to the ocular exercises these children had special reading aid until they could overcome their particular defects. All three patients are now reading satisfactorily, and keep up with their respective grades.

A careful reader may question why we have never mentioned the size of the

TABLE 9

RECORD OF PATIENTS WITH EXOPHORIA FOR NEAR AND DISTANCE

Case	Sex	Age	Phoria Cover Test N.	Phoria Cover Test D.	Rotoscope Ductions abd.	Rotoscope Ductions add.	Gl C W N.	Pilocarpine	Number of Exercises	Ductions After Exercises abd.	Ductions After Exercises add.	Sy. Cu R N.	Remarks
5	F	19	3	1	10– 8	18– 2	N	no	13	10– 8	45–35	Cu	
7	F	9½	10	7	15–10	28– 5	C	yes	19	8– 6	45–30	Cu	reading difficulty
15	M	28	6	4	10– 8	5– 4	C	yes	11	10– 8	22– 4	Cu	
24	F	18	4	2	8– 4	10– 8	C	no	6	8– 4	22–10	R	dropped out
25	F	17	4	1	14–10	18– 5	N	no	6	14–10	26–12	R	unable to continue
31	F	25	4	2	8– 4	4– 0	N	yes	21	4– 2	10– 5	N	pernicious anemia
32	M	36	6	2	8– 4	2– 0	N	no	14	10– 2	40–20	R	
39	M	31	3	2	7– 6	2– 0	N	no	5	7– 6	18–10	R	dropped out
44	F	16	4	2	8– 4	2– 0	C	no	20	10– 8	30–18	Cu	
47	F	54	14	4	8– 4	0	C	yes	18	10–10	20– 0	R	glandular
50	F	16	6	2	7– 4	6– 4	N	no	10	7– 6	40–30	Cu	
51	F	35	4	2	6– 4	10– 4	C	yes	28	8– 6	30–15	Cu	
55	F	21	12	6	8– 4	10– 5	W	yes	30	10– 8	30–20	R	occasional exercise
60	M	24	4	1	5– 2	5– 2	W	no	9	6– 4	30–10	R	dropped out
62	M	24	6	2	10– 8	5– 2	C	yes	38	10– 9	40– 9	Cu	
61	F	49	6	2	15–10	10– 3	C	yes	13	12–10	40– 0	N	glandular
67	F	9	4	2	10– 8	24–10	N	yes	29	10– 8	44–16	Cu	reading difficulty
69	M	29	6	2	6– 4	24–18	C	no	18	5– 3	38–22	Cu	
71	F	37	5	3	10– 8	10– 2	C	no	17	8– 6	40–20	Cu	
72	F	20	4	2	10– 8	10– 2	N	no	18	8– 6	35–20	Cu	
75	M	13	5	2	8– 6	10– 4	C	no	17	6– 4	40–30	R	
76	F	26	8	4	8– 2	4– 0	C	no	9	6– 4	20–10	R	dropped out
80	M	40	5	2	10– 8	20–10	C	no	7	10– 6	35–20	Cu	

TABLE 10

PERMANENCE OF RECOVERY

Case	Sex	Age	Ductions After Exercises abd.	Ductions After Exercises add.	Ductions at Later Date abd.	Ductions at Later Date add.	Length of Time Between Duction Tests	Symptoms at Final Examination
1	M	32	10– 8	40–15	10– 8	34–10	2 months	none
2	F	36	10– 6	45–16	10– 6	40–12	1 month	none
3	M	15	8– 4	45–30	8– 4	28–18	1 year	none
4	M	11	12–10	50–50	14–10	50–50	5 months	none
7	F	9½	8– 6	45–30	10– 8	40–30	5 months	none*
8	F	11	10– 8	45–30	10– 8	45–26	3 months	none
9	M	39	6– 4	28–20	10– 8	25–15	2 months	none
16	F	6	14–10	35–15	8– 5	24–20	6 months	some fatigue* (5 more exercises)
21	M	32	12– 8	45–30	12– 8	30–12	4 months	none
22	F	38	8– 5	30–12	8– 5	20–10	3 months	takes occasional exercise
63	F	33	8– 2	36–24	9– 8	30–10	2 months	none
46	M	15	12– 8	45–30	10– 8	40–30	3 months	none
23	F	27	14– 8	34– 5	10– 8	24– 5	2 months	(pregnant) some fatigue
66	F	16	5– 4	45–20	10– 6	44–10	2 months	none
67	F	9	10– 8	44– 8	10– 8	40–20	6 months	reading difficulty (recovered)*
38	M	22	10– 5	24– 9	10– 5	20– 9	2 months	none
81	M	31	12– 8	34–30	10– 8	24–15	4 months	none

* Associated with a reading difficulty

phoria either before or after training. As already stated, we do not attach much significance to the size of the phoria in determining the need for exercises. Our criterion is the patient's symptoms and the ductional balance as well as the near point of convergence. That this is more important than the actual size of the phoria is also shown from the observation that in almost all the cases the phoria did not change markedly. What did change, however, was the patient's ability to cope with it by increasing his adductional reserve and by improving his convergence. The phoria does have some influence on the training progress, as it influences the number of exercises required for recovery. For example, those patients who had no exophoria at all needed fewer exercises than those who had exophoria for near, or for near and distance. Again, the larger the exophoria for near the greater the number of exercises required for recovery. This is partly because the larger the exophoria the greater is the adduction reserve necessary to get comfortable near vision. In those cases the adduction must be great enough to overcome the phoria in addition to giving the normal amount of adduction.

Conclusion

1. Adduction and finger-convergence exercises were given to patients who after a cycloplegic refraction and proper fitting of glasses, had (a) an exophoria that was greater for near than distance; or (b) who had an exophoria for near only, and in conjunction with it, or alone, adduction weakness or generally poor abduction and adduction balance and subjective symptoms; or (c) who had no exophoria but only poor abduction and adduction balance.

2. Training was continued until normal ductional reserve was established and until the symptoms disappeared.

3. The exophoria is not necessarily eliminated by the exercises, but duction reserve was developed in order that the patient might cope with the existing phoria.

4. At times the symptoms were complicated by psychologic or neurotic manifestations. In those cases attempt was made to aid the patient in solving his personal problems. This reacted favorably upon the progress of the training.

5. If other complications existed medical care was advised. In several cases glandular disturbance was found and controlled, also a few cases of mild vitamin-B deficiency. Both conditions materially affected the muscle balance.

6. In children with reading difficulty a complete psychologic examination was made and specific reading aid advised in addition to the ocular exercises.

7. Fifty-three of the 80 patients recovered completely from their symptoms, and of those whom we had the opportunity to recheck after various intervals, almost all remained without symptoms and their ductions have stayed within normal limits.

25 East Washington Street.

References

[1] Mann, Ida C. Convergence deficiency. Brit. Jour. Ophth., 1940, v. 24, no. 8, p. 373.
[2] Holmes, Gordon. The cerebral integration of the ocular movements. Brit. Med. Jour., 1938, July 6, p. 107.
[3] Gesell, Arnold. The mental growth of the pre-school child. New York, The Macmillan Co., 1925, p. 447.

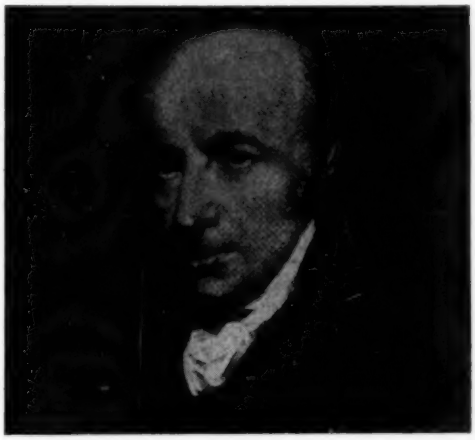
WOLLASTON AND HEMIANOPSIA*

JAMES E. LEBENSOHN, M.D., PH.D.
Chicago

In a recent drama entitled "Dark Victory" a young woman learns that she has a fatal brain tumor, but still achieves tranquillity and lives most fully her numbered days. Stranger and more dramatic than this fiction is the life story of that remarkable genius, William Hyde Wollaston.

Wollaston descended from a scholarly English family. Born near Norwich, August 6, 1766, he was the second of 17 children. His mother's uncle was the eminent Dr. William Heberden. His father, Reverend Francis Wollaston, was a noted divine and an astronomer of merit. Following the family tradition young Wollaston's formal education was completed in Cambridge and London. He devoted himself to medicine, graduating in 1793, but like Thomas Young, Helmholtz, and many another famous scientist failed to win recognition and success as a practitioner. Instead of infusing patients with cheer and confidence, the problems of diagnosis and treatment incited a tormenting anxiety in him that was all too obvious. A natural flair for research, however, was evidenced by his first publication in 1797, in which was completed the chemical knowledge of urinary calculi. On receiving a small legacy in 1800, he abandoned medical practice and at the age of 34 zealously embarked on a career of independent investigation. He carried on his experiments in a private laboratory in the greatest seclusion and with very few instruments. Almost from the start discoveries flowed in uninterrupted succession, covering a wide range of interests in chemistry, optics, and related fields.

While Wollaston was a striving physician he was refused a much-desired hospital appointment. Naturally reserved, he never sought another favor from society. Like Cavendish, he led a retired simple life, avoiding all but fellow scientists. Fond of amassing money, he would yet give generously to a worthy cause. He never married; his time and thought were entirely devoted to the library and the laboratory.



DR. WILLIAM HYDE WOLLASTON
(From a painting in the possession of the Royal Society.)

CHEMICAL CONTRIBUTIONS

In 1801 Wollaston effected chemical decomposition with statical electricity and so proved that frictional and galvanic electricity are of the same nature. A few years later he perfected a process of purifying and welding platinum and of making the metal malleable that eventually netted him about $150,000. In the black powder left

*From the Department of Ophthalmology, Northwestern University Medical School. Read before the Chicago Ophthalmological Society, December 16, 1940.

after platinum was removed from the parent ore Wollaston discovered the elements, palladium and rhodium, in 1803. Palladium was named after the newly observed asteroid Pallas; rhodium from the rose-red color of certain of its salts. Wollaston was the first to detect metallic titanium in the slag of iron furnaces. He published also analyses of meteoric iron, showed that potash exists in sea water, and devised a sliding scale of chemical equivalents.

Research in optics

In optics Wollaston proved to be both an exceptional observer and a brilliant inventor of original instruments. He was the first to report the presence of dark lines in the solar spectrum, although it remained for von Fraunhofer, 13 years later, in 1815, to appreciate their significance. He also demonstrated, in 1802, that the index of refraction of transparent or opaque media could be readily determined by simply utilizing the critical angle, a principle embodied in the Pulfrich and Abbe refractometers in modern use.

Having observed a mirage on the Thames, he became interested in atmospheric refraction and published his studies in 1803. In 1804 he patented meniscus lenses, which he termed "periscopic" because of their improved peripheral definition. Although originally three times as expensive as flat spectacle lenses they steadily gained in popularity.

By means of silver chloride Wollaston showed that the maximum chemical power of light resided in the invisible rays beyond the violet. He consequently shares with Ritter of Jena credit for the discovery of ultraviolet activity. In 1807 Wollaston designed the camera lucida, and it is interesting that this ingenious instrument inspired Fox Talbot's experiments in photography which in 1839 attained success, coincidental with Daguerre's independent discovery.

In 1809 Wollaston created the reflecting goniometer, which by rendering possible the exact measurement of crystals led Mitscherlich to discover the law of isomorphism—that when substances resemble each other chemically, their crystalline forms are likewise similar. In 1820 was described the double-image prism that Javal incorporated in his simplified ophthalmometer. Wollaston also contributed the microscopic doublet still used as the objective of the compound microscope, and an achromatic object-glass for enhancing telescopic definition.

Hemianopsia

Wollaston, who was himself the victim of hemianopsia, described the first cases of this disturbance on record. He deduced from the phenomenon that binocular vision in man is associated with semidecussation of the optic nerves. In Wollaston's[1] words:

"It is now more than 20 years since I was first affected with the peculiar state of vision to which I allude, in consequence of violent exercise I had taken two or three hours before. I suddenly found that I could see but half the face of a man whom I met, and it was the same with respect to every object I looked at. In attempting to read the name JOHNSON over a door, I saw only SON; the commencement of the name being wholly obliterated to my view. In this instance the loss of sight was toward my left, and was the same whether I looked with the right eye or the left. . . .

"It is now about 15 months since a similar affection occurred again to myself, without my being able to assign any cause whatever, or to connect it with any previous or subsequent indisposition. The blindness was first observed, as before, in looking at the face of a person I met; whose left eye was to my sight obliterated.

My blindness was in this instance the reverse of the former, being to my right (instead of the left) of the spot to which my eyes were directed; so that I have no reason to suppose it in any manner connected with the former affection.

"The new punctum caecum was situated alike in both eyes, and at an angle of about three degrees from the center; for, when any object was viewed at the distance of about five yards, the point not seen was about 10 inches distant from the point actually looked at.

"On this occasion the affection, after having lasted with little alteration for about 20 minutes, was removed suddenly and entirely by the excitement of agreeable news respecting the safe arrival of a friend from a hazardous enterprise.

"In reflecting upon this subject, a certain arrangement of the optic nerves has suggested itself to me, which appears to afford a very probable interpretation of a set of facts, which are not consistent with the generally held hypothesis of the decussation of the optic nerves. . . . Any two corresponding points must be supplied with a pair of filaments from the same nerve, and the seat of a disease in which similar parts of both eyes are affected, must be considered as situated at a distance from the eyes at some place in the course of the nerves where these filaments are still united. . . . According to this supposition, decussation will take place only between adjacent halves of the two nerves.

"Now, if we consider rightly the facts discovered by comparative anatomy in fishes, we shall find that the crossing of the entire nerves in them to the opposite eyes, is in perfect conformity to this view. . . . The relative position of the eyes to each other in the sturgeon, is so exactly back to back, on opposite sides of the head, that they can hardly see the same object; they can have no points which generally receive the same impression as in us; there are no corresponding points of vision required to be supplied with fibers from the same nerve. . . .

"A disorder that has occurred within my own knowledge in the case of a friend seems fully to confirm this reasoning. . . . In this case of diseased vision, we find apparent injury to one side of the brain, followed by blindness towards the opposite side of the point to where both eyes are directed.

"A series of evidence in such apparent harmony throughout, seems clearly to establish that distribution of nerves I have endeavored to describe, which may be called the semidecussation of the optic nerves. . . . We clearly gain a step in the solution, if not the full explanation, of the long agitated question of single vision with two eyes."

Wollaston's theory, popularized by the physiologist Johann Müller, was soon accepted. A half-century later, however, the question of semidecussation became a lively issue. Though Gudden apparently demonstrated its occurrence by a series of careful sections of the chiasma, Michel contended that in his personal histological studies the nerve fibers crossed completely. He argued that only by assuming total decussation could all possible forms of hemianopsia be logically explained. In the completely decussating nerves, pressure on the left external angle of the commissure would produce right hemianopsia; pressure on the anterior angle, bitemporal hemianopsia; pressure on the posterior angle, binasal hemianopsia. The semidecussation theory could not account for binocular nasal hemianopsia on the basis of a single lesion. Schoen countered that binasal hemianopsia, if it did exist, was extremely rare. Among other early champions of semidecussation were von Graefe, Hirschberg, Knapp, Mauthner, and Hughlings Jackson; and with the ac-

cumulation of postmortem evidence this viewpoint became definitely vindicated.

A HERO OF SCIENCE

Wollaston's papers, all given before the Royal Society, were characterized by precision of language and extreme caution in drawing conclusions. Besides chemistry and optics, their encyclopedic scope included acoustics, mechanics, astronomy, mineralogy, crystallography, botany, physiology, pathology, and even the fine arts. As an authority in science he was consulted by such as Davy, Faraday, Dalton, Lyell, Babbage, and Macintosh. At his suggestion the "imperial gallon" was standardized at that containing 10 pounds of distilled water at 62°F., equivalent, as the motoring tourist soon learns, to 1.2 U. S. gallons.

Towards the end of 1827, Wollaston noted an immobility of the right pupil and a numbness in the left arm. Told that he had a brain tumor and not long to live, he set about dictating papers on all his unrecorded work. When he became bedridden, he had an assistant under his direction carry on his uncompleted experiments in an adjoining room. His contributions were not his only legacies to science. He presented his valuable telescope, inherited from his father, to the Astronomical Society of London. On December 8, 1828, he left large sums to the Geographical Society, and on December 11th, to the Royal Society for the promotion of research. His demise was now a matter of days. As his end approached a friend at his bedside remarked that Wollaston no longer comprehended. Overhearing this, Wollaston motioned for pencil and paper, wrote in order the numbers from 500 to 520, then relaxed and died. The death of the scientist occurred on the twenty-second of December, 1828, a few months before the passing of his great contemporaries, Humphrey Davy and Thomas Young. Autopsy revealed that a tumor as large as a hen's egg had invaded the right optic thalamus. It is remarkable that in spite of such extensive cerebral disease his intellect, as he demonstrated, was unclouded to the very last.

20 East Delaware Place.

REFERENCE

[1] Wollaston, W. H. On semidecussation of the optic nerves (read February 19, 1824). Royal Society of London, Philosophical Transactions, 1824, v. 114, pt. 1, p. 222.

THE SAN FRANCISCO ORTHOPTIC LABORATORY*

A COÖPERATIVE ESTABLISHMENT

FREDERICK C. CORDES, M.D.
San Francisco, California

In recent years the science of orthoptics has made great advances. This has resulted in the development of a group of instruments the intelligent and successful use of which requires highly trained technicians. The task of training these orthoptic technicians has been recognized as an ophthalmological responsibility and has resulted in the establishment of the American Orthoptic Council, sponsored by the three national eye societies.

There must always be a close association between the ophthalmologist and the orthoptic technician. It is obvious that an accurate diagnosis must be made before intelligent treatment can be instituted. Only the eye physician is equipped to make a complete, detailed examination, including refraction under cycloplegia. He also must be certain that the refractive errors have been properly corrected. In addition, the diagnosis of paresis of a muscle is of greatest importance to avoid the uselessness of many hours of unsuccessful training. The ophthalmologist must also rule out the "physical defect"—squints, macular lesions, optic atrophies, congenital colobomata, or other congenital lesions which the orthoptist is not competent to diagnose. The complete and constant occlusion of the better eye when the amblyopic one has any of the above defects would obviously be contraindicated. The oculist must also be certain that constitutional disease, involvement of the nasal accessory sinuses, and dental irritation have been ruled out. In addition, the patient should be reexamined by him after every 8 to 12 lessons.

Ophthalmologists are beginning to realize that if orthoptic training is to produce the desired results, one of these highly trained technicians together with an array of rather expensive equipment is necessary. The ideal arrangement would be for the technician to be associated with the ophthalmologist. There are, however, very few offices that would have sufficient orthoptic patients to keep such a technician occupied. The operation by an ophthalmologist of such a plant, which would also accept patients from other oculists, would for obvious reasons not be feasible. The establishment of such an office owned and operated by a technician also does not, as a rule, completely solve the problem, as from our experience we have found that certain policies must be outlined and some decisions made which would be difficult or embarrassing for a technician.

Realizing the desirability of a properly equipped laboratory to which patients could be sent for orthoptic training under skilled guidance, a group of ophthalmologists organized the San Francisco Ophthalmic Laboratory. The stock of the laboratory was divided into 14 units, each of which guaranteed $25.00 a month support for the period of one year, during which the idea was to be on trial. In most instances, each man interested subscribed for a full unit; a few units, however, were divided among several men.

The equipment was chosen after careful deliberation. The most expensive single item was the synoptophore. It may

* Read before the joint meeting of Orthoptic Technicians and Ophthalmologists, at Cleveland, October 7, 1940.

not be amiss to say a little regarding this instrument. The synoptophore, or some form of major amblyoscope, is indispensable both for diagnosis and training. Accurate measurements of the angle of squint, the angle of anomaly, amount of incomitance, if any, the depth of fusion, and the amplitude of fusion are relatively simple procedures with this instrument. The diagnosis of false projection and suppression is a matter of seconds, and since the eyes of the patient are under constant observation the test can be used as an objective one, a tremendous advantage in dealing with children. Thus with this instrument a complete picture of the binocular state of the eyes can be obtained together with a measurement of deviations from the physiologic normal.

The synoptophore is also of the greatest value in training patients with squint, phorias, or ocular-muscle insufficiencies. Conditions such as false projection can be definitely removed and normal projection established by training on the synoptophore. It is rather generally believed that false projection cannot be broken up effectively or efficiently on any instrument except a major amblyoscope. If the false projection is not broken up before surgery, the patient has a postoperative paradoxical diplopia which he endeavors to overcome by placing his eyes in the old squinting position. This accounts for some of the temporary surgical "cures" we have all seen.

Another abnormal condition which training on the synoptophore will eradicate is constant suppression of the image of one eye or each eye alternately in alternating squints.

From the foregoing it is apparent that some form of major amblyoscope is necessary in any orthoptic laboratory.

In addition to the synoptophore, the cheiroscope has been found to be very valuable for children, for it holds the child's attention by the use of new or different exercises.

Aside from these items the laboratory equipment included a metronoscope (junior type), a stereo-orthopter, stereoscope, Worth four-dot test, visual-acuity chart, diploscope, Remy separator (two bar readers), near-point rule, fusion cards, and other minor items.

A bio-photometer was also installed, so that dark-adaptation tests are available to any physician. The equipment together with the necessary furnishings represents a total expenditures of approximately $1,500.00.

This well-equipped laboratory is conducted by a trained technician who holds the certificate of the American Orthoptic Council. The policies of the laboratory are decided by a committee of the ophthalmologists interested. Being a coöperative concern conducted to be run on a very narrow margin of profit, it has been possible to make the fees for training reasonable. The facilities have been made available to all reputable ophthalmologists.

The laboratory started operation in January of 1939, and since the first three monthly assessments has been self-supporting. The average monthly expense over a period of 18 months has been $307.16. Of this $150.84 was for salaries, $60.00 for rent, $1.51 for social security, $44.94 for depreciation, and $42.33 for miscellaneous expenses. The average fee for orthoptic treatments has been $2.50 with a fee of $20.00 for a course of 12. In some instances in which the patient could well afford it, the fee has been $5.00 a lesson, while a few isolated patients have paid only $1.25. For full orthoptic measurements the fee has been $2.50. All fees are collected directly from the patient by the technician and turned over to the treasurer of the committee,

who pays all bills. The books are audited regularly by a certified public accountant, and a report is made to the members.

The ophthalmologist sends the patient to the laboratory for an examination to determine whether or not orthoptic training is indicated and practical. The technician does not advise the patient of the result but sends the report to the physician. The oculist, in turn, decides—often after consultation with the orthoptist—the best course to be followed, and discusses the treatment with the patient, or in the case of a child, the parent. During the course of treatment the ophthalmologist is advised by report as to the progress made. Upon completion of the preagreed number of treatments, a written report is again sent to the patient's oculist and an appointment made for the patient to consult him. At this time the patient is reexamined by the ophthalmologist, who from his findings determines whether or not further treatment is indicated. Thus the control of the case remains in the hands of the ophthalmologist.

The laboratory has been in operation over a year and a half and has become increasingly busy, so that at the present time five sevenths of the total capacity for one technician is employed and further help will be necessary in the near future. The results have been excellent and have far surpassed those obtained under former methods.

Aside from the cases in which orthoptic training is indicated, the laboratory has another practical use. In recent years eye-muscle exercises in some form have been used so extensively for all types of ocular symptoms that the layman has become exercise conscious and often asks whether or not muscle training wouldn't relieve his symptoms or render unnecessary the use of glasses. It is invaluable in these instances to be able to explain to the patient what extensive facilities for muscle training are available and tell him that exercises will be recommended if indicated in his case. In some instances it has been advisable to send the patient to the laboratory for a diagnostic examination, so that he can be assured that orthoptic training would be of no avail.

In addition, much has been said recently in regard to reading speed, so that laymen and pediatricians at times inquire whether or not the child's poor school record may not be the result of his slow reading. After all other factors have been corrected it is very helpful to be able to send the patient to the laboratory to determine whether or not he reads the normal number of words per minute and, when it is below the average, to institute training.

With the orthoptic-training establishment described, there is also a possibility of expanding and installing such instruments as a retinal camera and perhaps later the necessary apparatus for the testing of aniseikonia. The operation of the laboratory thus far has convinced those of us associated with it that it is now an indispensable part of our armamentarium.

Recently Dr. Colin Graham of Vancouver, British Columbia, has called to my attention the fact that in Vancouver a similar laboratory was established in September, 1939. In 1925 a number of oculists organized their own prescription optical company, which now comprises 80 percent of the oculists. The Orthoptic Division is operated by this coöperative optical organization.

The technician is an orthoptist who is a graduate of the Royal Westminster Hospital of London and a member of the British Orthoptic Society. In addition to full orthoptic diagnosis and treatments, perimetry, scotometry, color tests, and visual-acuity tests are available. The fee of $1.50 for perimetry ($1.00 for scotometry if required independently) is

charged to the doctor. Facilities are also available for audiometry. The doctor sending the case controls the treatment, and progress reports are sent to him as frequently as indicated.

It is interesting to note that aside from the regular patients a considerable number of young men are taking orthoptic exercises. These boys are seeking to join the Royal Canadian Air Force and because of some muscular defect, such as poor stereoscopic vision, heterophoria, or convergence insufficiency, have been refused. Treatments usually have effected a cure. Thus orthoptics assumes its place in the military-defense program. Dr. Graham writes of the Orthoptic Division: "Personally, I feel that this clinic fills a long-neglected gap in our work, and while it is not a source of financial gain, it would be most unsatisfactory to feel that this forward step in ophthalmology was not available to my patients."

Approximately one year ago we were able to establish the Florence C. Noble Orthoptic Clinic at the University of California Medical School. The clinic is equipped with a synoptophore, cheiroscope, metronoscope, rotoscope, and other minor instruments. This work has been carried on by a full-time technician under the direction of Dr. George Campion. The results have also been convincing as to the value of these exercises in the proper cases if the necessary equipment and trained orthoptists are available. The importance of the properly trained technician cannot be overemphasized.

There should be little doubt regarding the desirability of making the proper orthoptic-training facilities available to every one. Judging from the experiences in San Francisco and Vancouver it would seem that proper orthoptic training can be made available in most communities if the ophthalmologists of that locality are willing to coöperate.

384 Post Street.

NOTES, CASES, INSTRUMENTS

THE LUCKIESH-MOSS TEST-CHART ILLUMINATOR*

MATTHEW LUCKIESH, D.Sc. AND FRANK K. MOSS
Cleveland, Ohio

The test-chart illuminator shown in the accompanying illustration was developed at the request of and in accordance with the specifications of the Advisory Committee of Ophthalmologists of the Eye-Health Committee of the American Student Health Association acting in coöperation with the National Society for the Prevention of Blindness. It is designed to illuminate the standard (1932) test-chart of the American Medical Association to a uniform brightness of 10 foot-lamberts with a manufacturing tolerance of plus or minus 2 foot-lamberts. Actually, an uncertainty in brightness of this magnitude may introduce a possible uncertainty of only 3 percent in visual acuity.[1] Since the test-chart itself is graded in steps of not less than 20 percent in visual acuity, the range in brightness tolerance of the illuminator is clinically insignificant.

The chart is illuminated by two 40-watt inside-frost Lumiline lamps placed horizontally above and below the chart. The light from these lamps is directed upon the chart by carefully designed and polished parabolic chromium-plated reflectors placed in shallow housings. Since the printed characters of the chart reflect light both specularly and diffusely, maximal contrast[2] between the black letters and white background is obtained by directing the light upon the chart at extremely acute angles. For this reason the light sources are placed horizontally above and below the chart rather than vertically along the sides. In fact, the contrast between the black letters and the white background is strikingly different for these two arrangements of light sources. A further advantage of our arrangement is that shallow

Fig. 1 (Luckiesh and Moss). A new illuminator for the 1932 A.M.A. chart designed to produce a uniform brightness over the entire chart.

*From the Lighting Research Laboratory, General Electric Company.

lamp housings are required and hence shadows resulting from light sources located elsewhere in the examination room are minimized. Notwithstanding the inherent difficulties of lighting from such acute angles it is practically possible to obtain such a degree of uniformity in brightness that the maximum variation from the average brightness of various areas of the chart does not exceed 5 percent in either the horizontal or vertical directions. Obviously, the uniformity of the illumination on the chart, as well as the level of illumination, will be influenced by the general lighting in the examination room. However, the visual-acuity ratings obtained in practice should not be significantly altered by the ambient illumination, if the latter amounts to only a few foot-candles.

All exposed surfaces of the illuminator are coated with a dull crystallized gray finish having a reflection factor of about 40 percent. The latter represents a median value between the "white" chart and the average wall surface against which the chart will be viewed. Thus the distraction of high brightness-contrasts between the illuminator and its surroundings, as well as between the illuminator and the chart, are minimized.

A bright fixation light for use in conjunction with the Maddox rod is provided by viewing an inside-frosted lamp through a circular aperture having a diameter of one centimeter. This light source is controlled by a separate switch and provides a brightness of 25 candles per square inch. This attachment, located on the bottom lamp housing, is hinged so that it disappears into the lower housing when not in use.

This equipment may be obtained from The Welch Allyn Company of Auburn, New York.

Nela Park.

References

[1] Cobb, P. W., and Moss, F. K. The four variables of the visual threshold. Jour. Franklin Institute, 1928, v. 205, p. 831.

[2] Luckiesh, M., and Moss, F. K. The science of seeing. New York, D. Van Nostrand Company, 1937.

AMERICAN JOURNAL OF OPHTHALMOLOGY

Published Monthly by the Ophthalmic Publishing Company

EDITORIAL STAFF

DERRICK VAIL, *Editor-in-Chief*
837 Carew Tower, Cincinnati
EDWARD JACKSON, *Consulting Editor*
Republic Building, Denver
WILLIAM H. CRISP, *Consulting Editor*
530 Metropolitan Building, Denver
LAWRENCE T. POST, *Consulting Editor*
640 S. Kingshighway, Saint Louis
WILLIAM L. BENEDICT
The Mayo Clinic, Rochester, Minnesota
GRADY E. CLAY
Medical Arts Building, Atlanta
FREDERICK C. CORDES
384 Post Street, San Francisco
HARRY S. GRADLE
58 East Washington Street, Chicago
RALPH H. MILLER
803 Carew Tower, Cincinnati
C. S. O'BRIEN
The State University of Iowa, College of Medicine, Iowa City
M. URIBE TRONCOSO
500 West End Avenue, New York
ALAN C. WOODS
Wilmer Ophthalmological Institute, Baltimore
GEORGE A. FILMER, *Assistant Editor*
Abstract Department
1114 Republic Building, Denver
EMMA S. BUSS, *Manuscript Editor*
2500 Kemper Lane, Cincinnati

Directors: LAWRENCE T. POST, President, WILLIAM L. BENEDICT, Vice-President, DONALD J. LYLE, Secretary and Treasurer, EDWARD JACKSON, WILLIAM H. CRISP, HARRY S. GRADLE, FREDERICK E. WOODRUFF, DERRICK VAIL.

Address original papers, other scientific communications including correspondence, also books for review and reports of society proceedings to *Dr. Derrick Vail, 837 Carew Tower, Cincinnati.*

Exchange copies of medical journals should be sent to *Dr. William H. Crisp, 530 Metropolitan Building, Denver.*

Subscriptions, applications for single copies, notices of change of address, and communications with reference to advertising should be addressed to the *Manager of Subscriptions and Advertising, 837 Carew Tower, Cincinnati.* Copy of advertisements must be sent to the manager by the fifteenth of the month preceding its appearance.

Author's proofs should be corrected and returned within forty-eight hours to the *Manuscript Editor, Miss Emma S. Buss, 2500 Kemper Lane, Cincinnati.* Twenty-five reprints of each article will be supplied to the author without charge. Additional reprints may be obtained from the printer, the George Banta Publishing Company, 450-458 Ahnaip Street, Menasha, Wisconsin, if ordered at the time proofs are returned. But reprints to contain colored plates must be ordered when the article is accepted.

UVEAL DISEASE

In the third volume of the textbook of Duke-Elder, on "The eye and its diseases," 443 pages are devoted to diseases of the uveal tract. This group of diseases has gradually risen to its present importance. Before routine use was made of the ophthalmoscope, the uveal pathology of the eye was very obscure, practically unknown. Disease of the iris, particularly acute inflammation, was recognized by its symptoms; and the intimate relation of the ciliary body to the iris gave currency to the term "iridocyclitis," which is still applied to many diseases of the uveal tract. Clinical use of the ophthalmoscope begins to show that involvement of the choroid may be as common as lesions of the ciliary body. In the Royal Society of Medicine in London, February 25, 1941, the Sections of Medicine and of Ophthalmology held a discussion on Iridocyclitis. Sir Maurice Cassidy, president of the Section on Medicine, presided. In the discussion Dr. W. D. W. Brooks, Col. F. Juler, Dr. R. D. Lawrence, Mr. F. A. Williamson-Noble, Prof. A. J. Ballantyne, and Dr. F. W. Crofton took part. Their observations, from widely differing points of view, showed how incomplete are the recognized facts regarding this group of eye conditions. They suggest how much light may be thrown, by discussion, on lesions of other parts of the eye.

Roughly grouping eye lesions by the

coats of the eye in which they occur, we have come to recognize that the sclerocorneal coat is protective, and the retina is neurosensitive and coördinative. But the uveal coat is preëminently nutritive. The sclera and retina depend largely on the uveal coat for nutrition. Both sclera and retina have vessels of their own, but the uvea is the great vascular bed of the eye. In the choroid we can watch, with interest and advantage, the struggle against tuberculosis. Sometimes this ends with complete involvement of the fundus, and practical blindness. More frequently the result is healing of the uveal lesions, useful vision, normal body weight, and active outdoor life. That has been the result in the case recorded in the Osler Memorial Volume. The patient still has good health after 30 years.

The choroid may be the first tissue to reveal metastasis of malignant disease, as in cancer of the posterior mediastinum or of the lungs. Its relation to general nutrition makes it possible to discover here the effects of obscure general disease, and thus to identify which of several diseases is present. What has been called albuminuric retinitis involves the choroid as soon, and quite as much, as the retina. In vascular hypertension, uveal changes may sound the first warning for preventive measures.

The nutritive function of the uveal coat, especially of the choroid, makes it particularly liable to lesions caused by abnormal metabolism. Gout, diabetes, rheumatism, syphilis, and leprosy are recognized as causes of uveal disease. The fact, pointed out by Adler, that the vitreous always contains less sugar than the aqueous humor, and the observations of Bernand Samuels regarding what he calls "iritis serosa" remind us that the uveal coat has a peculiar relation to intraocular nutrition. Recently "brucellosis" has been found to cause changes that were first thought to be due to tuberculosis. Wide acquaintance with uveal lesions and careful examination of them may make it possible to discriminate between underlying causes in cases of obscure ocular disease.

Edward Jackson.

PROGNOSIS IN UVEAL SARCOMA

The notorious malignancy of uveal sarcoma depends upon the tendency to metastasis, not only during the existence of the intraocular growth, but also after removal of the eyeball or even after exenteration of the orbit.

Much has been written about the protection afforded by the unperforated sclera, yet the significance of this factor has probably been overestimated, and some authors have even expressed doubt as to whether the incidence of metastasis was any less without than with perforation of the sclera.

Although most writers agree that the benignancy of the prognosis varies directly with the promptness of diagnosis and enucleation or exenteration, Hippel, who reviewed a great number of cases, questioned the possibility of asserting as a general truth that early enucleation gave a good prognosis and late removal of the eyeball a bad one.

Much importance in estimating the prognosis of enucleation or exenteration has been attached to the cellular structure of the tumor. Thus the spindle-cell type was generally credited with being least and the epithelioid type with being the most malignant.

More recently, much attention has been devoted to another detail of tumor structure which seems to possess special significance. In 1935 Callender and Wilder (American Journal of Cancer) published the results of a study as to the prognostic significance of argyrophile fibers in melanotic tumors. They pointed out that the

tendency of these tumors to metastasize varied inversely with the quantity of reticulin (one of the three types of connective-tissue fibers) which such tumors contained.

Callender divides melanotic tumors into three main groups: group one, in which reticulin fibers are abundant throughout the growth; group two, containing an abundance of reticulin fibers in some areas, but few or none of these fibers in other areas; and group three, in which reticulin fibers are abundant except at the periphery of the growth or at the periphery of individual masses of cells, without penetration between the cells.

Group two is subdivided into A, B, and C. In Group 2A, although reticulin is not present throughout, it is abundantly present in more than one half of the growth. In group 2B reticulin is present throughout about one half of the growth. In 2C, reticulin is found in less than one half of the microscopic section.

It is necessary to demonstrate the argyrophile reticulin fibers by a special staining technique, the most satisfactory being probably that of Foot as modified by Wilder. With this special stain the reticulin fibers, not demonstrable by ordinary stains, stand out sharply black against the brownish color of the tumor cells and their nuclei.

According to Callender, a much more adequate prognosis is to be had by using, in conjunction with classification according to cell type, the new classification according to the relative abundance or absence of reticulin fibers. Thus, out of 120 cases studied by Callender for one year or more after enucleation or exenteration, none of the patients belonging to group one had died of metastasis and only 22 percent of those in group 2A; whereas death from metastasis had occurred in 76 percent of those in group 2B, in 87 percent of those in group 2C, and in 100 percent of those in group three.

As might be expected, other authors have reported statistics whose percentages vary slightly from those of Callender. Terry and Johns found rather similar results in a series of 65 cases. Pahwa (British Journal of Ophthalmology, 1941, volume 25, page 241) has applied the principles enunciated by Callender, with the staining method of Foot and Wilder, to 76 cases treated and studied at the Royal London Ophthalmic Hospital (Moorfields). (Pahwa's study of mortality included a larger number of patients, but in regard to only 72 of these were the pathologic specimens available for investigation of the significance of argyrophile fibers.) The tumor classification (spindle-cell, fascicular, epithelioid mixed-cell) was determined by the study of slides stained with hematoxylin and eosin. The condition of the patient was ascertained by mail inquiry or by personal visit, and records were made of the reticulin content of a complete section of each growth. Most of the patients had been operated upon more than five years, and none less than three years previously.

Pahwa's paper reproduces many excellent photomicrographs, and reviews the work of other authors. Out of one hundred patients who had been treated for uveal sarcoma during the period from 1930 to 1935 inclusive, 51 were still alive, 10 could not be traced, and 27 were known to have died from metastasis.

Pahwa confirms the principle laid down by Callender that the more the reticulin the better the prognosis. In group one, including 20 patients out of the total of 72, Pahwa records only one death from metastasis, although there was one other patient of this group whom it had been impossible to trace.

Groups 2A, 2B, and 2C showed respectively 3, 3, and 15 deaths from metastasis, out of the total numbers of 16, 10, and 19

given in Pahwa's table as belonging to these groups. Group three (reticulin almost completely absent) showed five deaths out of seven patients.

It appears that alike among spindle-cell growths, ordinarily regarded as the least malignant type of uveal sarcoma, and among epithelioid growths, commonly accepted as highly malignant, the degree of malignancy is enhanced by the absence of reticulin fibers.

Pahwa devotes some space to the old question whether there is a limit beyond which permanent cure of uveal sarcoma may be assumed. He quotes with approval Hippel's dogma that there is no such limit. In Hippel's series of 189 cases, 37 deaths from metastasis occurred within five years after enucleation, 13 after from five to nine years, and only 3 after ten years. Denecke recorded one death from metastasis more than fourteen years after enucleation, while Terry and Johns mention four deaths from nine to twelve years after enucleation. However, a patient who has passed the five-year period may be regarded as approximately safe from metastasis. But is it also worth remembering that somewhere near one half of all patients who have had sarcoma of the uveal tract die of metastasis in spite of enucleation or exenteration.

W. H. Crisp.

OPHTHALMOLOGY IN BRAZIL

The fourth Biennial Brazilian Congress of Ophthalmology was held in Rio de Janeiro from the 26th of June to the 1st of July, under the presidency of Professor Rego Lopes. It was almost international in character, for attendance included guests from Guatemala, Argentine, the United States, and Brazil. In general, the meeting was conducted along the lines of the now-defunct International Congress of Ophthalmology. The official themes were Injuries to the eyes, Glaucoma, Trachoma, and Social ophthalmology. But ample space was left for individual contributions, limited to a presentation time of five minutes. There were 116 of these presentations since, contrary to our custom, several members presented two and even three papers. Difficulties with the languages spoken and limited space prevent the reporting of outstanding aspects of some of the more important papers. These will be published at length in the official Transactions of the Congress.

The social aspects of the Congress were not neglected. The chief event consisted of a full day's excursion to Petropolis. This summer resort is situated in the hills and is reached over an excellent mountain road, winding ever upward and revealing breath-taking vistas at each turn. The scenery is reminiscent of the gorgeous Valley of a Thousand Hills, outside of Durban in South Africa. On another day there was a joint luncheon at the Lido on beautiful Copa Cabana Beach, followed by a reception at the palace by the president of Brazil, Dr. Getulio Vargas. Visits to the leading hospitals and institutes were arranged for the early morning hours.

Modern ophthalmology, as we understand it, is practiced in Brazil. The equipment in the public institutions and in the private offices is modern and up-to-date and the case records evidence the refinements of diagnosis and therapy. The older equipment is German, but is being rapidly replaced by instruments of the American Optical Company and of Bausch and Lomb, the latter firm maintaining factory-trained representatives in Rio. Many of our large clinics are far less complete than are some of the Brazilian public institutions, and the better private institutions represent the last word. Many of the busier ophthalmologists have from 2 to 10 beds and an operating room adjoining their private offices.

The Brazilians themselves say that organized ophthalmology there has not progressed as far as desired and for that reason they are most vitally interested in the Pan-American Congress of Ophthalmology. By learning and avoiding the mistakes that we in the United States have made in the past years, they hope to be able to attain the effective organization that pertains in the North in half the time that we, as pioneers, required. Coöperation, not sponsorship, is the key note of the desired relationship between the ophthalmologists of the Americas. They wish to eliminate the domination that has characterized the now defunct leadership of the Old World and to join hands with their colleagues of the New World in a fraternal, not a paternal, pact.

Probably the most important act of the fourth Brazilian Congress of Ophthalmology was the establishment of a Central Council of Ophthalmology, corresponding to the American Board of Ophthalmology. To that Council were appointed the 11 professors and the 11 assistant professors of ophthalmology of the medical schools of Brazil, the 6 presidents of the ophthalmological societies, and a representative of the Pan-American Congress of Ophthalmology. The latter is the liaison officer with the Boards in the other American Republics, present and future. The purpose of the Council is the advancement of ophthalmology in Brazil through the establishment of national standards, the certification of ophthalmologists who conform to those standards, and the holding of future examinations for purposes of certification. The Council has wider powers and scope of action than has the American Board. This is most indicative of the progressive trend of thought of the Brazilian profession.

The fifth Brazilian Congress of Ophthalmology will be held in Bahia in June, 1943. The principal themes will deal with Glaucoma, Vitamins in ophthalmology, and Social ophthalmology. I can assure the United States ophthalmologists who may plan to attend that they will receive a welcome cordial beyond expectations and a happy experience well worth the long trip. They will be delighted with the scientific ophthalmology to be found in Brazil and will come to a more acute realization that the future of ophthalmology lies in the Western Hemisphere.

Harry S. Gradle.

THE TUBERCULIN REACTION IN OPHTHALMOLOGY

Recent investigations on cutaneous sensitivity in experimental ocular tuberculosis have indicated that a tuberculous lesion localized within the scleral envelope may not influence profoundly the reactivity of the skin to tuberculin. Studies of the cutaneous sensitivity to tuberculin in patients with both clinically and histologically proved ocular tuberculosis have similarly indicated that many such patients may be relatively nonreactive to the intracutaneous injection of tuberculin. In view of these findings it has become increasingly difficult to evaluate the diagnostic significance of this tuberculin reaction in ophthalmology.

A positive reaction to tuberculin is essentially a manifestation of hypersensitiveness to tuberculo-protein, and occurs following an infection of the organism with tubercle bacilli. Different species of animals show such hypersensitivity in varying degrees. In man, an active or recent infection with tubercle bacilli usually produces a high degree of cutaneous hypersensitivity. Clinically, the original method of testing for tuberculin hypersensitivity was the subcutaneous injection of first 1.0 c.c. of O.T., then 5.0 c.c., then 10.0 c.c., and if no reaction was observed to repeat the last dose. A positive reaction was manifested by a general reaction consisting of an elevation of temperature and

concomitant general symptoms, a local reaction consisting of inflammation and induration at the site of injection, and a focal reaction consisting of an exacerbation of inflammation at the site of the lesion.

It soon became apparent that this method was not applicable to patients with ocular tuberculosis. The focal reaction about the ocular lesion was occasionally of such severity that the eye was irreparably damaged. The Calmette test, later introduced, was also unsatisfactory, since the local reaction occurred in the eye itself. The cutaneous reaction, introduced by von Pirquet, was unsatisfactory except in children under two years, practically all adults reacting more or less violently to the cutaneous-scratch test. The intracutaneous test, introduced by Mantoux, however, gave ophthalmologists a safe and accurate method of determining in their patients the cutaneous reactivity to tuberculin. The more recent patch test, introduced by Vollmer in 1937, is likewise eminently safe in patients with ocular tuberculosis insofar that it does not produce focal reactions. It is also more specific in adults than is the von Pirquet test. However, as usually employed, it does not permit the easy quantitative determination of sensitivity, and there are as yet insufficient reports of this test on patients with ocular tuberculosis to permit any evaluation of its specificity in comparison to the intracutaneous test.

The tuberculin employed in the intracutaneous test is usually O.T., although equally reliable determinations may be made with the purified protein derivatives (P.P.D.). Inasmuch as the majority of reports on patients with ocular tuberculosis are based on the test with O.T., and since O.T. is stable and inexpensive, it would appear wiser to employ it as the routine antigen, at least until sufficient information has been accumulated with P.P.D. in eye patients to compare the results with those given by O.T.

In actual practice the Mantoux intracutaneous test is performed as follows: Three dilutions of O.T. are prepared, 1:100,000, 1:10,000, and 1:100. An intracutaneous injection of 0.1 c.c. of each of these dilutions is given in the forearm, raising a wheal about one half the size of a dime. A similar control injection with salt solution and preservative is given in the other arm. The actual doses of tuberculin are therefore 0.001, 0.01, and 0.1 mg. If these test injections give negative results, larger amounts, 1.0, 5.0, and even 10.0 mg. may be given later. If positive, a smaller amount, 0.0001 mg., may be given. General and focal reactions are usually never observed after such intracutaneous injection. The local reaction, with inflammation, induration, and occasionally superficial necrosis, occurring 48 hours after the injection, is the only evidence of a positive reaction.

In actual practice, it was found that the great majority of normal, clinically nontuberculous adults gave positive local reactions to 0.1 mg. of O.T. intracutaneously, and many apparently normal individuals may react to 0.01 mg. Patients with active systemic tuberculosis, pulmonary, osseous, and the like, showed a much more marked sensitivity, reacting usually to 0.01 or 0.001 mg. and even to smaller doses, 0.0001, and so on. It therefore became generally accepted that a reaction to 0.001 mg. was definitely indicative of either an active or a recently healed tuberculous lesion somewhere in the body. Negative reactions were observed only in noninfected individuals, in far-advanced tuberculosis when the patient went into a state of anergy, or in completely healed tuberculosis. Therefore, provided the patient did not have an obvious advanced systemic infection, a negative reaction to tuberculin was interpreted

to be definite evidence against the tuberculous nature of the clinical lesions.

On the strength of these accepted beliefs, ophthalmologists interpreted a reaction to 0.001 mg. as evidence of an active tuberculous infection, and if there were no other manifest systemic tuberculous lesions that might account for this hypersensitivity, the ocular lesion was assumed to be the cause, and the diagnosis of ocular tuberculosis appeared justified. Conversely, a relatively negative Mantoux reaction was assumed to be direct evidence against a tuberculous nature of an ocular lesion.

This interpretation of the Mantoux reaction was widely accepted by ophthalmologists, and was usually the deciding factor for the acceptance or rejection of the diagnosis of ocular tuberculosis. Clinical studies, however, soon cast doubt on the validity of these premises, and reports from both European and American clinics indicated that the cutaneous reactions to tuberculin in patients with clinical ocular tuberculosis did not differ greatly from those of apparently normal adults. In view of high tuberculin sensitivity found in patients with active pulmonary or bone tuberculosis, the relative cutaneous nonreactivity of patients with ocular tuberculosis was difficult to understand. As a result, many ophthalmologists began to doubt the value of the Mantoux test in patients with ocular tuberculosis, while others became frankly skeptical of the actual diagnosis.

The recent investigations on animals and humans appear to shed some light on this enigma. A tuberculous lesion localized in the eye apparently does not give sufficient antigenic stimulus with tuberculo-protein to affect regularly the cutaneous sensitivity. Systemic lesions, on the other hand, give a greater antigenic stimulus, especially in the pulmonary or osseous system, since the lesions are larger and absorption is greater. The cutaneous sensitivity to tuberculin is therefore more regularly heightened.

The present indications are that the Mantoux test for tuberculin hypersensitivity is not valueless in ocular tuberculosis, but our interpretation of the reaction should be somewhat modified. A negative reaction to 0.01 or even to 0.1 mg. is not positive evidence against the ocular lesion's being tuberculous, but merely indicates that in this particular patient the reaction is simply without diagnostic significance. A positive reaction, especially to smaller doses, 0.001, or even 0.0001 mg., in the absence of a demonstrable systemic lesion to which such hypersensitivity might be attributed, is presumptive evidence that the ocular lesion may be tuberculous. If the clinical picture is compatible with tuberculosis and there is no evidence of other systemic disease that might cause the ocular lesion, such a strongly positive tuberculin reaction gives reasonable grounds for a diagnosis of ocular tuberculosis.

Alan C. Woods.

THE GENTLE ART OF READING A MEDICAL JOURNAL

Harvey Cushing, in the introductory lecture to his class, advised his students not to purchase an expensive treatise on surgery. He said that by the time a textbook appeared it was already on the way to becoming antiquated, and that furthermore no textbook could adequately cover the scope of the subject. He suggested instead that his students read and study the surgical journals, make and file notes on each subject, and by the end of the year each would have his own textbook, not only on record but, what was more important, in his head.

Those who followed the advice of this great teacher found his words to be true and many continued this student

habit after graduation, with much profit and enjoyment to themselves and benefit to their patients. Some there are who found it to be a delightful hobby, like stamp collecting, and would take pleasure in mulling over their collection from time to time. As experience developed, discrimination evolved, and worthless notes were thrown away, the valuable ones kept. One of the beauties of the system is that it can be begun at any time, and once begun the habit grows.

One reads a medical journal in order to store knowledge for clinical use, or to obtain ideas for research, or to see what someone else is doing, or to satisfy an insatiable curiosity, or to keep abreast of the tide of new ideas.

The purposes of reading a medical journal are obvious, the methods of reading may be worthless and time wasting. There are even those who subscribe to and then put away their journals unread. At the end of the year the copies will be removed from their original wrappers, collected together, nicely bound, and placed on the shelves, where they at least satisfy the instinct of ownership. Others will tear out and file the articles that interest them and throw away the rest. Some save their copies for what might be called cloacal reading. A few find that the journals are a cure for insomnia.

Emulating Adler, whose book, "How to read a book," was a best seller a season or so ago, a discussion of profitable methods of reading and filing of the material should receive favorable attention, and perhaps stimulate one or two to put some of the ideas here expressd into practice.

The journal should first be read from cover to cover the important or interesting articles reread, and the pertinent sentences underlined. These sentences are then transferred to a card or piece of paper for filing. Some prefer the ordinary filing card of different sizes according to taste, which fit into an appropriate cabinet. The new photograph albums that have a number of grooved hinges on each page, may be fancied. Loose-leaf pages can be used and filed under suitable headings, into notebooks similar to that supplied by the American Academy of Ophthalmology and Otolaryngology. Or, if one chooses, the remarks can be written into the margin of a favorite textbook. One of the best methods of filing, perhaps, is that of making the notes on pieces of thin tissue paper that have a gummed margin. These are to be found made up into pads in any stationery store. It is a simple matter to moisten the margin of these strips and fasten them onto the proper page in a standard textbook without marring it.

Psychologists point out the importance of association in fixing the memory of newly learned facts. It is sound practice, therefore, to hitch up the information in the notes with the experience of one's own cases. In this way what might have been an isolated fact becomes a link in a chain of knowledge forming the foundation for intuition.

Journal clubs where members present digests from the literature have the advantage of dividing the labor of abstracting, but they do not accomplish so much for the individual as he would by his own work. Besides it is hard to fit the time of meeting into a full schedule, and these clubs, useful and valuable as they are, may soon perish from neglect.

The art of reading a medical journal is truly a gentle one. It fosters a contemplative vision in the quiet of the study, promotes the welfare of humanity without bluster or threat, instills courage to press on in the hour of discouragement, and pulls the lagging spirit from the rut of daily chore. It catches the fleeting butterfly of thought and impinges it. It

deserves the consideration of men of good will.

Derrick Vail.

BOOK NOTICES

MANUAL OF THE DISEASES OF THE EYE. By Charles H. May, M.D., and Charles A. Perera, M.D. Seventeenth edition, revised. Clothbound, 519 pages, 387 illustrations, 93 colored figures. Baltimore, William Wood and Company, 1941. Price $4.00.

A TEXTBOOK OF OPHTHALMOLOGY. By Sanford R. Gifford, M.D. Second edition. Clothbound, 470 pages, 255 illustrations, 40 colored figures. Philadelphia, W. B. Saunders Company, 1941. Price $4.00.

New editions of these well-known textbooks for students and practitioners have simultaneously appeared. For this reason they are grouped together for review purposes.

May's textbook has been revised and some parts rewritten. Some new illustrations have been added, others replaced or deleted. An appendix giving the ocular requirements for admission to the armed forces of the United States is included. The familiar grouping of chapters is maintained. The popularity of this book is attested by the many translations (10) into foreign languages, the latest being the editions appearing in Portuguese and Urdu (India). There is nothing but the usual praise to say for this book.

Gifford's textbook has likewise been thoroughly revised and parts rewritten. A valuable change is to found in the chapter on the relations between fundus changes and cardiovascular renal disease, with a classification of these changes in accord with modern conceptions.

The poor illustrations that marred the first edition have been replaced by better ones, and the addition of 15 new colored cuts has been a great improvement. The result is a textbook that brings out the best of modern ophthalmology.

The competition between these two textbooks has improved the quality of each. It may be hard on the authors and publishers but the students and practitioners are the gainers. It now becomes a difficult decision for a teacher of ophthalmology which one to recommend. Both could be studied with advantage. It might be wise to have half of the class buy one and the second half the other, and interchange.

Derrick Vail.

ORBITAL TUMORS: RESULTS FOLLOWING THE TRANSCRANIAL OPERATIVE ATTACK. By Walter E. Dandy, M.D., Clothbound, 164 pages, 100 illustrations. New York, Oscar Piest, 1941. Price $5.00.

Every ophthalmologist of experience has encountered cases of orbital tumors in which the orbital approach, either thought the upper lid, or conjunctiva, or by the Krönlein operation, has proved to be costly. Costly to the eye itself due to the trauma of the operation, or to the patient because of the intracranial extension of the growth and its incomplete removal.

Since 1934, according to Alan C. Woods, M.D., who has written a preface to this work, patients with orbital tumors in the Johns Hopkins Hospital have been operated upon only after consultation between the ophthalmological and neurosurgical services. All tumors lying deep in the orbit, and invariably any tumor of which there is any reason to suspect an intracranial extension, are routinely referred to the neurosurgical service for surgery. Other cases, in which the tumor is in the anterior portion of the orbit, are taken care of by the ophthalmologist.

Dr. Dandy describes 31 cases, in which, by means of the hypophyseal approach and removal of as much of the orbital roof as seemed necessary, the orbital tumor and the intracranial extension if present were removed. Sixteen percent of his patients had Schüller-Christian disease. This high percentage would indicate that the diagnosis of this apparently rare disease has been frequently missed elsewhere. Twenty-nine percent showed dural meningioma with hyperostosis of the skull. A study of 12 other conditions completes the series. Details of nearly every case are given and beautifully illustrated, although more information regarding the ophthalmic aspect might have been noted to our advantage. In six, or 20 percent, of the cases studied the tumors were confined solely to the orbit.

The importance of the monograph is enhanced by the report of the pathologic study of the material, and by the complete description of the operative procedure. There is no index.

The author has made out a strong case for this approach to the problem of orbital tumors and the operative risk (4.1 percent in this series) in safe hands is probably not unreasonable. The ophthalmologist will profit by a perusal of this book.

Derrick Vail.

OBITUARY

HERBERT WRIGHT WOOTTON
M.D. 1867-1941

Dr. Wootton died on February 28, 1941, after a short illness.

He was born on December 25, 1867, in the City of New York. In 1888 he graduated from the Columbia University College of Physicians and Surgeons. In 1898 he became associated with the Manhattan Eye, Ear, and Throat Hospital, and in 1924 was appointed surgeon director.

He devoted much of his time to the care of children's eyes, and for 21 years was a member of the Board of Health of New York City.

His society memberships included the Section on Ophthalmology of the New York Academy of Medicine, New York Ophthalomological Society, and the American Ophthalomological Society. His clubs were Columbia University, Quill, the Loyal Legion, and Sons of the Revolution.

Dr. Wootton was beloved by his friends, patients, and associates, to whom he gave unstintingly of his great store of knowledge. Many years of his life were devoted to graduate teaching, in which he was deeply interested because he wanted to do all in his power to advance ophthalmology and especially to aid the student.

He spoke German, French, and Italian fluently. He was an Episcopalian and a staunch believer in the democratic way of life.

His wife, Florence Randolph Sanders, his son, Edward Wright Wootton, and his daughter, Anne Hillhouse, survive.

Dr. Wootton was a gentleman of the old school and a leader in ophthalmology who endeared himself to so many friends that his loss is keenly felt. His life, accomplishments and ideals will remain for inspiration in the memory of those whose privilege it was to know him.

Conrad Berens.

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP
ASSISTED BY DR. GEORGE A. FILMER

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

4

OCULAR MOVEMENTS

Gifford, S. R. **Results of surgical treatment of paralysis of the superior oblique and superior rectus muscles.** Arch. of Ophth., 1941, v. 25, May, pp. 761-772.

Eight cases of paralysis of the superior oblique muscle and five of paralysis of the superior rectus muscle in which operations were performed are reported in tabular form, with a discussion of certain practical points suggested by the observations. Exact diagnosis is of paramount importance, and Bielschowsky's method is recommended as giving the most satisfactory results. Operative treatment is very gratifying as patients greatly appreciate any relief from diplopia or improvement in the binocular fields. In cases of paralysis of the trochlear nerve, which is usually accompanied by overaction of the inferior oblique muscle, myotomy of the homolateral inferior oblique muscle will usually be advised first and will frequently give a sufficient effect. If the effect is insufficient, recession of the opposite inferior rectus muscle will be employed. In cases of extreme hypertropia in which the two previous procedures have proved to be insufficient, recession of the homolateral superior rectus muscle should be considered. In cases of moderate paralysis of the superior rectus muscle, myotomy of the contralateral inferior oblique muscle is done first, and will usually prove sufficient. If not, advancement and resection of the paralyzed muscle are indicated and only if hypertropia remains marked after these procedures should recession of the homolateral inferior rectus muscle be advised.

J. Hewitt Judd.

Hildreth, H. R. **The insertions of the levator palpebrae muscle.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 749-758.

Lancaster, W. B. **Fifty years experience in ocular motility.** Amer. Jour. Ophth., 1941, v. 24, pp. 485-496; June, pp. 619-624; and July, pp. 741-748;

also Trans. Pacific Coast Oto-Ophth. Soc., 1940, v. 25, p. 21.

Verhoeff, F. H. **Occlusion hypertropia.** Arch. of Ophth., 1941, v. 25, May, pp. 780-795.

The term occlusion hypertropia is suggested for the condition variously called alternating hyperphoria, double hyperphoria, and alternating hypertropia, since these are misnomers. Facts are presented showing that three conjugate mechanisms can be differentiated, two monocular and one binocular. Occlusion hypertropia is due to congenital monocular conjugate insufficiency and may be unilateral or bilateral. This conjugate insufficiency may concern the superior oblique muscle, the inferior rectus muscle, or both, although usually it concerns chiefly the superior oblique muscle. This condition is usually associated with other oculomotor defects which are probably congenital. It is not infrequently associated with nystagmus and often with a congenital hypoplasia of one or both fourth nuclei, producing the effect of so-called overaction of one or both of the inferior oblique muscles. In deciding upon the treatment, operative or otherwise, to be employed in cases of strabismus or heterophoria, it is important to recognize and allow for occlusion hypertropia. The author suggests that monocular conjugate insufficiency of one or more of the lateral rectus muscles may also occur.

J. Hewitt Judd.

5

CONJUNCTIVA

Babel, J. **Corneal involvement in the course of inclusion conjunctivitis of the newborn.** Ophthalmologica, 1941, v. 101, March, p. 129. (See Section 6, Cornea and sclera.)

Bogdanov, I. L. **Diphtheria of the eye.** Viestnik Opht., 1940, v. 17, pt. 5, p. 625.

Because of the mildness of its course diphtheritic conjunctivitis in infants may run its course undiagnosed. Of 65 patients treated in 1938, 22 had involvement of other organs. The rest were cases of primary conjunctivitis. Recovery usually took place from five to seven days after administration of antitoxin. In order to avoid spread of the disease in nurseries, the author urges careful examination of skin sores, cracks about the nose, and infections around the nails. Ray K. Daily.

Bowen, Ralph. **Allergic conjunctivitis.** Southern Med. Jour., 1941, v. 34, Feb., p. 184.

The author divides allergic conjunctivitis into two types: vernal and nonvernal. Botanical and environmental factors are present in the vernal but food is never an offender. Vernal conjunctivitis is described and diagnosis and treatment are given. Reports are made on 14 of the author's own cases.

In nonvernal types the importance of a good history is stressed and the method of making tests is given. Bacteria, food, environment, and fungi are discussed. To search out offenders a visit to the home of the patient by the physician personally is considered imperative. F. M. Crage.

Doherty, W. B. **A discussion of pterygia and report of a new technique for their removal.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 790-794.

Feldmann, M. F. **Early diagnosis of trachoma on the basis of the cytologic picture of the tarsal conjunctiva.** Ophthalmologica, 1941, v. 101, Feb., p. 74.

An early diagnosis of trachoma may

be made from a study of scrapings of the tarsal conjunctiva stained by the Giemsa method. In a preparation from normal conjunctiva, the epithelial cells are close together in groups; the nuclei are oval, of equal size, and their staining is uniform and saturated. This corresponds to the normal histologic picture of the conjunctiva of the tarsus which has a two-layered cylindric epithelium. In trachoma, the polymorphism of the cells is striking. The epithelial cells are dispersed; the nuclei are round, variable in size and larger than usual, staining irregularly, and pale. In healed trachoma the cytologic picture becomes normal. These observations were found to be consistently true in 356 cases of trachoma.

F. Herbert Haessler.

Friedman, Benjamin. **The supernumerary caruncle.** Arch. of Ophth., 1941, v. 25, April, pp. 664-668.

A man aged 46 years presented two small lobular masses, side by side on the inner surface of the lower lid. The growths were well below the level of the lid margin and were invisible until the lid was everted. The nasal mass was situated just under the lower punctum, the other mass was connected with it by a narrow bridge of tissue. Except for this point of fusion, the lobules were quite free from each other and were entirely independent of the caruncle. The growths were fixed to the underlying tarsus by a small base, but the major portion of the mass was freely movable. The masses were flat and measured about 3.5 mm. in diameter and about 2.5 mm. in thickness. Except that the epithelium consisted of columnar cells, simulating the cell shape of the lid conjunctiva rather than that of the normal caruncle, the structure was similar to that of a normal caruncle. The growths were easily removed and microscopic study substantiated the clinical diagnosis. The theories of causation are discussed.

J. Hewitt Judd.

Katznelson, A. B., Kachan, Z. Z., and Tufa, H. Z. **Carbohydrate metabolism in the acute and latent periods of phlyctenular disease.** Viestnik Opht., 1940, v. 17, pt. 5, p. 556.

The study was made on 36 patients. The detailed report shows in the majority of the patients a pathologic shift in carbohydrate metabolism, manifested in lowered absorption of glucose and accumulation of lactic acid in the blood. The carbohydrate metabolism in patients with recurrent phlyctenules is characterized by instability, and clinical recovery is followed by restoration of normal carbohydrate metabolism. These laboratory findings give a scientific basis to the clinical observation of reduced sugar tolerance in patients with phlyctenulosis, and of the provocation of recurrence by excessive sugar intake. The data also indicate a high degree of instability of the vegetative nervous system in patients with phlyctenulosis, caused by a dysfunction and lack of correlation between the sympathetic and parasympathetic systems. The clinical application of this study would call for a definite restriction in the carbohydrate intake, instead of the usual broad instructions for the observance of a proper dietetic and hygienic régime. Ray K. Daily.

Luo, T. H., and Chang, E. **Sulfanilamide in the treatment of trachoma.** Chinese Med. Jour., 1940, v. 58, Nov., pp. 512-526.

Forty patients with active trachoma were treated with sulfanilamide, administrated orally. Thirty-two cases

(80 percent) were cured, and the remaining eight cases were considerably improved. The average time required for a cure was three months. The healed cases had been followed several months without recurrence. The symptoms improved earlier than the objective changes, and the follicles disappeared more quickly than the papillary hypertrophy. The bacterial flora was found to have no influence on the effect of the therapy. Only a few mild toxic reactions were encountered.

T. E. Sanders.

Mullen, C. R. **Treatment of gonorrheal diseases of the eye with sulfanilamide.** Arch. of Ophth., 1941, v. 25, April, pp. 655-658.

A series of 42 patients treated with sulfanilamide included 14 infants with gonorrheal ophthalmia neonatorum and 28 patients with gonorrheal infection of the conjunctiva and cornea. All of the 14 infants were discharged without corneal involvement, but in the other group were five patients with corneal complications. The results show a remarkably lessened incidence of corneal complications and a decrease in the duration of hospitalization. Treatment now used at the Philadelphia General Hospital is sulfanilamide internally in doses of 1 to 2 grs. per pound of body weight, but never more than 100 grs. the first 24 hours; and irrigations of the involved eye with 2-percent boric-acid solution followed by free instillation of 0.8-percent sulfanilamide at ten-minute intervals, day and night. After the first 24 hours, the internal dose of the drug is decreased to 0.25 or 0.5 grain for each pound of body weight, and local irrigations are continued at increased intervals. Treatment also includes the use of atropine-sulphate solution, iced compresses for ten minutes every hour, and the use of a Buller shield when only one eye is involved. Patients are considered ready for discharge after negative smears on three successive days.

J. Hewitt Judd.

Radzichovskii, L. B. **Treatment of trachoma by suction.** Viestnik Opht., 1940, v. 17, pt. 5, p. 655.

An analysis of 173 cases treated by the method previously reported by Radzichovski (Amer. Jour. Ophth., 1939, v. 22, p. 939). The author claims that removal of the follicles by suction is accomplished with less traumatism than by expression, and that the tissue fluids and defensive bodies fill in the vacuum left by the follicles and promote healing. Ray K. Daily.

6

CORNEA AND SCLERA

Babel, J. **Corneal involvement in the course of inclusion conjunctivitis of the newborn.** Ophthalmologica, 1941, v. 101, March, p. 129.

In eight of 86 cases of inclusion-body conjunctivitis in newborn infants, a deep keratitis was observed. The condition starts two or three weeks after a conjunctival inflammation with pseudomembrane formation, and healing may leave extensive opacities. The corneal affection heretofore seems to have escaped notice; at least it has not been reported. In one patient the corneal lesion was accompanied by glaucoma, in another by a severe encephalopathy similar to the encephalitis seen in rabbits experimentally inoculated with herpes virus. F. Herbert Haessler.

Cogan, D. C. **Some practical considerations pertaining to corneal edema.** Arch. of Ophth., 1941, v. 25, April, pp. 552-556.

The change occurring on the corneal surface when cocaine is used is due largely to the hypotonicity of the solution rather than to any direct toxic action, and can be practically eliminated by adding sufficient sodium chloride to the solution to make it approximately isotonic with tears. The corneal opacity resulting during certain procedures, especially operations for separated retina, and that occurring with the use of contact glasses, may be avoided by the use of a 1.5-percent solution of sodium chloride. The corneal edema which occurs with acute glaucoma and prevents adequate ophthalmoscopic study may be greatly diminished by bathing the cornea in a 10-percent solution of sodium chloride for a few minutes.

J. Hewitt Judd.

Filatov, V. P., and Bazshenova, M. A. **Experimental transplantation of dried and frozen cornea.** Viestnik Opht., 1940, v. 17, pt. 5, p. 536.

This laboratory investigation on rabbits demonstrated the resistance of the cornea to chemical and bacterial processes. Dryness of the cornea and low temperature are the two factors in this resistance. The data show that cornea which has lost nearly all its water content may form a transparent implant if it is moistened soon after it is dried. Excellent results are obtained with cornea which has lost 15 to 20 percent of its original weight, with subsequent conservation at 2 to 4°C. Freezing exerts a more deleterious influence on the cornea. Preserved at −3°C, the corneal transplants retain transparency, but the integrity deteriorates with further lowering of temperature. The isolated preserved cornea gives better results than cornea from a preserved eyeball. These data corroborate the conclusions based on studies of tissue cultures by Filatov. (Illustrations.)

Ray K. Daily.

Imre, Josef. **Clinical and histologic studies on corneal transplantation.** Orvosi Hetilap, 1941, v. 85, no. 13, p. 157.

Studies of histologic preparations indicate that a corneal transplant does not become gradually replaced by new tissues developed by epitheliogenic keratoblasts of neighboring structures, but that the whole transplanted disc with all its layers remains intact. Between the basic tissues and the transplant a fine scar tissue was found in all preparations. Vessels never entered the disc.

R. Grunfeld.

Inciardi, J. A. **Blood-staining of the cornea.** Arch. of Ophth., 1941, v. 25, May, pp. 863-865.

A patient aged 61 years had two operations on one eye, both accompanied by hyphemia, yet neither causing corneal staining. The intraocular tension was normal. In the other eye, however, there was an increased tension following an iridectomy, and typical blood-staining occurred. The corneal stain cleared considerably during 15 months of observation, and the clearing was much more rapid after the intraocular tension had been reduced to normal.

J. Hewitt Judd.

Langer, Z. M. **Awerbach's technique of covering the corneal graft with cadaver conjunctiva.** Viestnik Opht., 1940, v. 17, pt. 5, p. 555.

Cutting a large conjunctival flap, suturing it to the uncut conjunctiva of the patient, placing the sutures so that the needle indicates the epithelial surface, and using a colored suture to indicate the position of the transplant—these are details worked out by the

author to facilitate the procedure.

Ray K. Daily.

Lyle, T. K., and McLean, D. W. **Vitamin C (ascorbic acid)—its therapeutic value in inflammatory conditions of the cornea.** Brit. Jour. Ophth., 1941, v. 25, June, pp. 286-298.

The authors (working independently in two separate R.A.F. hospitals) used large doses of ascorbic acid in the treatment of inflammatory conditions of the cornea. Ten cases are reported in support of the findings. The conclusions are that: (1) treatment by means of ascorbic acid has dramatic therapeutic value in those corneal conditions involving ulceration, superficial type of keratitis, and chronic corneal opacities; (2) no general vitamin-C deficiency was found in the majority of cases, so that the beneficial result was due to flooding the blood stream with an excess of ascorbic acid; (3) in the treatment of iritis, ascorbic acid was found to be detrimental in some instances: (4) there was no general or local reaction to the injections used; (5) the daily injection of 500 mgs. until active inflammation of the eye has ceased is recommended. In all instances the usual local treatment was given in addition to the injections of ascorbic acid. (Tables, references.)

D. F. Harbridge.

Pillat, A. **Allergy and the eye, with special consideration of allergic corneal disease.** Wiener klin. Woch., 1940, v. 53, Dec., pp. 1005-1009.

The author gives a summary of all the known allergic ocular diseases. Allergic disease of the conjunctiva has two distinct forms: (1) the acute form, characterized by edema, as in the conjunctivitis accompanying hay fever due to pollens, or that produced by bacterial allergens, especially staphylococci, or by some chemical allergens such as henna; (2) the chronic form, characterized by formation of follicles as seen in atropine conjunctivitis, or in allergy to eserine, cocaine, or naphthaline. Chronic folliculosis, especially that found in school children, is mostly produced by dust. Vernal conjunctivitis also belongs to the chronic group, although its allergen is unknown as yet.

Among the allergic diseases of the uveal tract, certain types of sympathetic ophthalmia, and the spontaneous, usually bilateral, choroidal detachment, are enumerated. Allergic phenomena in the retina and central visual pathways are those accompanying migraine, and consist mainly of vasospasms. They are often caused by allergy to food (beans, chocolate, grapes, fats). Tar preparations and naphthaline may also produce them.

The author discusses in detail the allergic diseases of the cornea and distinguishes four clinical pictures, illustrating them with case reports: (1) Hyperkeratosis and parakeratosis of the cornea, which can be diagnosed only by means of the slitlamp. The subjective symptoms are itching and burning without visual disturbance. (2) The most common form is superficial punctate keratitis. The author considers keratitis nummularis (Dimmer) and the epidemic keratoconjunctivitis as belonging to this group, but states that more investigation is necessary to clarify the status of these conditions among the allergic diseases. (3) Certain cases of catarrhal ulcers represent only the marginal form of allergic corneal disease. (4) The most characteristic allergic corneal disease is keratitis diffusa superficialis. The corneal epithelium is stippled and often stains diffusely with fluorescein, and

behind the epithelial lesion, usually between the anterior and middle thirds of the stroma, there is a narrow but strikingly homogeneous zone of infiltration which can be best demonstrated with the narrow beam of the slitlamp. Keratitis filamentosa and striata are perhaps only variations of this diffuse superficial allergic keratitis.

Bertha A. Klien.

Reiser, K. A. **The pathogenesis of neuroparalytic keratitis.** Münch. med. Woch., 1940, v. 87, Nov., pp. 1201-1203.

Among the many theories dealing with the pathogenesis of neuroparalytic keratitis, the neurotic theory (Wilbrand-Sanger, Behr) that irritation of the trigeminal fibers rather than their disturbed function is the cause, is the most generally accepted by ophthalmologists. In surgical circles there are still many adhering to the trophic, trophic-traumatic, and traumatic theories (Magendi, Graefe, Snellen), based mainly upon the Wallerian law of descending nervous degeneration and reduction of corneal resistance.

In favor of the neurotic theory of irritation is the often late development of keratitis (up to ten years after operation), which can be explained by increasing scar traction, the marked proliferation of the corneal epithelium after therapeutic abrasion in cases of neuroparalytic keratitis, and the increased growth of cilia on the side of the keratitis.

After extirpation of the Gasserian ganglion in rabbits typical degeneration is found in the large corneal nerves (knobby swelling, globular disintegration of the fibers). The smaller corneal nerves show much fewer lesions, the preterminal network contains a diseased fiber only here and there, and the terminal reticulum remains entirely normal. Probably not the trigeminal fibers originating in the root but those heterogenous fibers joining the trigeminus from the vegetative nervous system are the source of the irritation which leads to keratitis. The peripheral portions of the vegetative nervous system are a network with many anastomoses, thus complete descending atrophy does not occur.

Bertha A. Klien.

Shartz, S. E. **Clinical data on transplantation of cadaver cornea.** Viestnik Opht., 1940, v. 17, pt. 5, p. 543.

The transplant took in all of thirty cases. During the postoperative period none of the transplants was completely transparent. To determine the final result, cases have to be followed a long time because the transplant may become less or more transparent as time goes on. In 18 of the cases vision was improved, but vision above 0.1 was obtained in only two cases. In eyes predisposed to glaucoma a prophylactic antiglaucomatous operation should be performed. (Illustration.)

Ray K. Daily.

Sydenstricker, V. P., Kelly, A. R., and Weaver, J. W. **Ariboflavinosis, with special reference to the ocular manifestations.** Southern Med. Jour., 1941, v. 34, Feb., p. 165.

Characteristic ocular findings, especially those observed with the slitlamp, are discussed in detail. The condition is differentiated from other corneal diseases. Riboflavin therapy is considered. Next to the tongue the first tissue to respond to vitamin therapy is the cornea. The improvement in the more severe cases of keratitis is slow, large-vessel obliteration sometimes requiring a year's time.

F. M. Crage.

Wasserman, I. A. **Methods of producing experimental leucomata.** Viestnik Opht., 1940, v. 17, pt. 5, p. 549.

The objective of this investigation was the production of scars suitable for experimental keratoplasty. The data show that the introduction of 10-percent trichloracetic acid and 20-percent lye into the cornea produces suitable cicatrices with a smooth and reaction-free postoperative course. Superficial burns may be produced by 20-percent sulphuric acid. For thin superficial opacities, diathermy with a double-needle electrode may be used. Paquelin cautery produces dense coarse adherent leucomata. Ray K. Daily.

7

UVEAL TRACT, SYMPATHETIC DISEASE, AND AQUEOUS HUMOR

Grignola, Antonio. **Morphology of the elastic structure of the iris.** Rassegna Ital. d'Ottal., 1940, v. 9, March-April, pp. 259-281.

The irides of 43 eyes, aged from 8 months fetal life to 99 years, were studied with great care, using the various well-known elastic-tissue stains. The presence of elastic-tissue fibers was normal and constant, but was subject to individual variations independent of the age of the subject. The various morphologic aspects of elastic tissue are described and beautifully illustrated, and the probable action and function are explained. (12 figures.)

Eugene M. Blake.

Holst, J. C. **Contributions to the question of etiology and treatment of sympathetic ophthalmia.** Ophthalmologica, 1941, v. 101, Jan., p. 8.

The author reports his experience with five cases of sympathetic ophthalmia. All occurred in children with negative tuberculin reactions. It is not advisable to postpone prophylactic enucleation more than 12 days. In three of the author's patients enucleation was done on the twelfth or thirteenth day. In two of them sympathetic inflammation started four and six weeks later respectively. In the one case of sympathetic ophthalmia in which the eye healed with good vision, neoarsphenamine was used. F. Herbert Haessler.

Kaufman, S. I. **Uveoparotitis (Heerfordt).** Arch. of Ophth., 1941, v. 25, April, pp. 659-661.

A woman aged 22 years suddenly developed a Bell's palsy on the right side, and at the same time noted swelling in the left parotid area. Four days later the eyes became painful and congested. In about two weeks the palsy cleared, but a similar palsy developed on the left side. There was a low-grade fever throughout the course. The disease lasted over a year, reaching its greatest intensity within the first six months. None of the remedies produced any striking change in the progress of the condition. The media became so cloudy that the details of the fundus could not be made out. Eventually the media began to clear, and the deposits on the cornea, the iris, and the anterior capsule of the lens began to disappear. The vision gradually improved to 20/30 for the right eye and 20/20 for the left eye. Treatment included the use of atropine sulphate, dionin, local heat, hyperthermy, X ray over the eyes and parotid region, and sulfanilamide. In spite of the protracted and stormy course of the disease, the uveitis appears to have a marked tendency to spontaneous recovery. Since the cause is unknown the treatment is entirely symptomatic. J. Hewitt Judd.

Luzsa, Endre. **Facts concerning the question of tension difference between the chambers.** Orvosi Hetilap, 1941, v. 85, no. 15, p. 208.

A seven-year-old boy exhibited congenital anomalies in both eyes. In the right eye there was an incomplete coloboma of the iris and a persistent hyaloid artery; in the left eye a dark brown vesicle 3 mm. in diameter protruded into the anterior chamber. The vesicle consisted of the pigmentary layer protruding through a narrow underdeveloped part of the iris. The vesicle remained expanded as long as the patient looked at a distance, but when he was looking at a near point the vesicle collapsed and became wrinkled. The vesicle would further collapse at the slightest pressure on the cornea such as that produced by the blinking of an eyelid. Pupillary movements, whether induced by light and darkness or by eserine and atropine, had no influence upon the shape of the vesicle. In the behavior of this vesicle the author sees proof of the existence of pressure difference between the chambers, and he concludes that pupillary movements do not influence this pressure difference.

R. Grunfeld.

Riwchun, M. H., and De Coursey, E. **Sympathetic ophthalmia caused by non-perforating intraocular sarcoma.** Arch. of Ophth., 1941, v. 25, May, pp. 848-858. (See Section 15, Tumors.)

Samokhina, E. F. **Comparative evaluation of the effect of calcium and pilocarpine ionization on the enlarged blind spot.** Viestnik Opht., 1940, v. 17, pt. 5, p. 600.

The results of this investigation show that calcium ionization diminishes the size of the blind spot, enlarged by retinal edema, in tuberculous choroiditis and in glaucoma. Pilocarpine by instillation or ionization causes a contraction of the blind spot of glaucoma, but has no effect in tuberculous choroiditis.

Ray K. Daily.

8

GLAUCOMA AND OCULAR TENSION

Barkan, Otto. **Choice of operation in glaucoma.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 768-778.

Berens, Conrad. **Curved knives for sclerectomy operations for glaucoma.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 804-805.

Corrado, Antonio. **Exfoliation of the lens capsule in glaucoma.** Rassegna Ital. d'Ottal., 1940, v. 9, March-April, pp. 294-317.

Exfoliation of the anterior lens capsule was observed in the left eye of a man of 70 years. Chronic glaucoma existed in both eyes. The case is interesting because of the presence of the "central discoid of Vogt." Peripheral lens changes were entirely lacking. The author doubts that the exfoliation precedes the glaucoma as the tension was higher in the affected eye and the capsule was not exposed to the pupillary play in this area. Relief of tension and retention of vision are less easily effected in this type of glaucoma. (5 figures, bibliography.)

Eugene M. Blake.

Ershkovich, I. G. **The influence of muscular exercises on intraocular tension in glaucoma.** Viestnik Opht., 1940, v. 17, pt. 5, p. 586.

The material consisted of 25 patients between and 19 and 66 years of age (14 men and 11 women). Running reduced tension in 50 percent of the glaucoma cases, but this form of exercise

is not generally suitable for glaucoma patients, many of whom have cardiovascular disturbances. Walking, which is suitable for glaucoma patients, reduced tension in 35.4 percent of the cases and the reduction lasted from 9 to 12 hours. The fall in tension occurred most frequently in chronic inflammatory glaucoma. There was no parallelism in the effect on the intraocular and vascular tension. Elastotonometric studies on 14 eyes showed the favorable effect of walking in half the cases. These studies confirm Filatov's contention that muscular exercise is a factor in the regulation of intraocular tension. Ray K. Daily.

Ferrer, Horacio. **Conjunctival dialysis in the treatment of glaucoma recurrent after sclerectomy.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 788-790.

Heath, Parker. **Secondary glaucoma due to the lens.** Arch. of Ophth., 1941, v. 25, March, pp. 424-437; also Trans. Amer. Ophth. Soc., 1940, v. 38, p. 258. (See Section 9, Crystalline lens.)

Reese, A. B. **Glaucoma surgery during the last ten years.** Surg. Gyn. and Obstet., 1941, v. 72, Feb. 15, pp. 490-498.

The author reviews the literature of glaucoma surgery for the past ten years. He discusses the modifications of standard procedures and describes the relatively new techniques. He believes that the trend is toward earlier operation in chronic simple glaucoma. T. E. Sanders.

Samokhina, E. F. **Comparative evaluation of the effect of calcium and pilocarpine ionization on the enlarged blind spot.** Viestnik Opht., 1940, v. 17, pt. 5, p. 600. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

Schmelzer, Hans. **Liver-function test in patients with glaucoma.** Graefe's Arch., 1939, v. 141, pts. 2 and 3, pp. 266-295.

In comparing the blood chemistry of glaucoma patients with that of normal individuals of the same age, it was found that the former group had hypercholesterinemia and gave a positive xanthoprotein test. These findings indicate a disturbance in liver function. The author conducted liver-function tests on glaucoma patients and normal persons of the same age. The tested individuals received 50 gm. of gelatin in addition to their daily protein intake. In patients with liver damage, there is an increase of amino-acids in the blood and urine, due to the inability of the liver to deaminize the increased protein load. All of the tested glaucomatous patients, regardless of the stage and type of glaucoma, showed disturbance of protein metabolism as compared with the normal controls. On the basis of these findings, the author believes that primary glaucoma is the result of disturbed metabolism with ensuing changes in the blood chemistry and in the concentration of the intraocular fluids. Charles A. Perera.

Seidenari, Renato. **Glaucomatous cataract.** Rassegna Ital. d'Ottal., 1940, v. 9, March-April, pp. 216-231.

The author describes several cases of cataract complicating glaucoma, or following antiglaucomatous surgery. Some occurred in acute and some in chronic glaucoma, and careful slitlamp examinations are recorded. The percentage of cataract is small in acute glaucoma, and it is suggested that one keep in mind the possible development

and perhaps rapid progress of such cataracts after glaucoma operations. (3 figures.) Eugene M. Blake.

Sugar, H. S. **Gonioscopy and glaucoma.** Arch. of Ophth., 1941, v. 25, April, pp. 674-717.

The author discusses the gonioscopic appearance of the normal chamber angle, and his gonioscopic technique. The gonioscopic findings of the chamber angle in cases of primary glaucoma not treated by operations, both congestive and noncongestive, are described. The gonioscopic appearance of the chamber angle in cases of secondary glaucoma is described as found in capsular glaucoma, following cataract operations and other trauma, healed acute iridocyclitis, hemorrhagic glaucoma, glaucoma associated with dislocated subluxated lenses, with intumescent lens, and with anomalies of the chamber angle, including hydrophthalmia, juvenile glaucoma, aniridia, congenital coloboma of the iris, and spherophakia. The author reports the postoperative gonioscopic observation of eyes with primary glaucoma following iridectomy, cyclodialysis, Elliot trephining, iris-inclusion operations (iridotasis, iridencleisis), Lagrange sclerectomy, goniotomy, and Vogt's cyclodiathermy. The author's method of goniophotography is also described. The various conditions found are well depicted by goniophotographs, including one color plate.

J. Hewitt Judd.

Zimin, V. I. **Diathermy and calcium ionization of the neck in the treatment of glaucoma.** Viestnik Opht., 1940, v. 17, pt. 5, p. 597.

This form of physiotherapy was introduced by Scherbak in 1916 and is based on the direct action of diathermy on the cervical ganglion and spinal portion of the vegetative nervous system. Calcium ionization acts as a reflex stimulant to the vegetative centers in general and the parathyroid glands in particular. Five brief case reports illustrate the effectiveness of these procedures in reducing intraocular tension.

Ray K. Daily.

9

CRYSTALLINE LENS

Bellows, J. G., and Chinn, H. **Biochemistry of the lens. 13. Production of lens opacities by injection of hypertonic solutions.** Arch. of Ophth., 1941, v. 25, May, pp. 796-810.

Cataracts were produced in dogs and rats by continuous intravenous injections of various crystalloids for periods varying from twenty minutes to seven hours. Solutions (approximately isotonic with a solution of 10-percent sodium chloride) of sodium sulphate, lithium chloride, sodium chloride, galactose, arabinose, xylose, glycerin, ethylene glycol, aminoacetic acid, sodium lactate, and ethyl alcohol were effective cataractogenic agents when administered in this manner. Regressive changes were observed if the injections were discontinued after cataract was apparent and the animal allowed to recover. A loss in weight of the whole eye followed the intravenous injection of 10-percent sodium chloride. Among the individual tissues, the lens showed the greatest percentage loss of water, with the retina, cornea, sclera, and vitreous following in that order. After injection of sodium chloride each of the ocular tissues showed a marked rise in sodium and chloride, with the exception of the lens which remained almost unchanged. Of the organs and skeletal tissues, the muscle showed the greatest

rise, followed by the kidney, liver, heart, lung, and spleen in that order. The osmotic pressure (as measured by the freezing-point depression) of the blood, aqueous humor, and spinal fluid increased directly with the rise in sodium and chloride of these fluids. The hemoglobin content of the blood decreased during injection, indicating hemodilution. The ascorbic acid, glutathione, and nonprotein nitrogen concentrations of the cataractous lens did not differ from those of the normal lens. The potassium content of the cataractous lens was slightly higher than that of the normal lens. The possible significance of these findings in the pathogenesis of cataract is discussed. J. Hewitt Judd.

Cooper, E. L. **A new tip for Dimitry's suction syringe.** Arch. of Ophth., 1941, v. 25, April, p. 671.

In order to allow the lens to be visible while being grasped, the gold tip of the Dimitry syringe is replaced by a suction cup made of transparent plastic material. J. Hewitt Judd.

Corrado, Antonio. **Exfoliation of the lens capsule in glaucoma.** Rassegna Ital. d'Ottal., 1940, v. 9, March-April, pp. 294-317. (See Section 8, Glaucoma and ocular tension.)

Cosmetatos, G. F. **Remarks on intracapsular cataract extraction.** Ophthalmologica, 1941, v. 101, Jan., p. 1.

The author bases his remarks on his own experience in performing 1,302 cataract operations since January, 1936. In 80 percent of the cases he used the intracapsular operation. Homatropine is used the day before operation and once just before the procedure. Cosmetatos advocates a single conjunctival suture, and in most operations a peripheral iridectomy. Much less vitreous loss is encountered when the lens capsule is grasped as low as possible.

F. Herbert Haessler.

Cullom, M. M. **An operative technique for traumatic cataract.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 803-804.

Gillette, D. F. **Effect of thyroxin on incipient senile cataracts.** Arch. of Ophth., 1941, v. 25, March, pp. 438-442.

After briefly reviewing the literature, the author presents the results in twenty cases treated with thyroxin and three control cases. He concludes that thyroxin used locally does not check the development of senile cataract nor cause absorption of the opacities present. He points out that visual acuity alone is not an index of the progress of incipient senile cataracts. Thyroxin does not have any demonstrable local metabolic effect. J. Hewitt Judd.

Heath, Parker. **Secondary glaucoma due to the lens.** Arch. of Ophth., 1941, v. 25, March, pp. 424-437; also Trans. Amer. Ophth. Soc., 1940, v. 38, p. 258.

Cases of glaucoma attributable to abnormality of the lens may be divided into two groups: first, those with the lens in position; second those with the lens out of position, partly suspended or luxated. In the first group are cases due to: (1) defective lens development associated with other defects of the iris and filtration angle, (2) irritation of the ciliary processes due to contact with the lens, (3) toxic substances escaping through the permeable capsule, (4) desquamation of the capsule, (5) uveitis with iris bombé, (6) blocking of the angle from escaped swollen cortex, and (7) endophthalmitis phacoanaphylactica. In the sec-

ond group are cases caused by: (1) luxation of congenital type, (2) traumatic luxation, (3) luxation into the anterior chamber, (4) phacocele, (5) luxation into the anterior vitreous, causing ciliary irritation, (6) luxation into the posterior central vitreous, producing low grade uveitis, and (7) luxation of the lens against the retina or disc, causing severe uveitis. The author concludes that although some patients carry a partially tilted lens for many years without resulting inflammation and secondary glaucoma, yet in view of the likely course of events, the conservative treatment calls for removal of the lens when tilting or partial luxation is seen in association with inflammatory changes. A lens sharply luxated or weakly suspended should be removed. (Photomicrographs, discussion.) J. Hewitt Judd.

Kessler, Emma. **Two rare cataract forms.** Ophthalmologica, 1941, v. 101, Jan., p. 19.

The author describes two unusual forms of cataract: (1) a circumscribed central cataract which involved the superficial strata of the posterior cortex of a lens with rudimentary posterior lenticonus in a child of 5½ years; (2) a total tetany cataract in a woman of 36 years. F. Herbert Haessler.

Kirby, D. B. **Prevention and handling of complications arising during and after cataract extraction.** Arch. of Ophth., 1941, v. 25, May, pp. 866-901.

The author presents many practical points regarding operative technique and preoperative and postoperative care. General complications considered are drug reactions, delirium, retention of urine, and respiratory, gastrointestinal, vascular, and cardiac disorders. Local complications discussed are hemorrhage, loss of vitreous, prolapse of iris, failure of apposition and healing of the wound, corneal opacity, infection, inflammation, and glaucoma.

J. Hewitt Judd.

Patch, E. M. **Cataracts in amblystoma-tigrinum larvae fed experimental diets.** Proc. Soc. Exper. Biol. and Med., 1941, v. 46, Feb., p. 205.

Cortical cataracts of two types resulted from feeding salamander larvae synthetic diets of varying protein constituency. Description of the diets and observations of the lens changes are given. F. M. Crage.

Riwchun, M. H. **Albino with senile cataracts.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 798-800.

Seidenari, Renato. **Glaucomatous cataract.** Rassegna Ital. d'Ottal., 1940, v. 9, March-April, pp. 216-231. (See Section 8, Glaucoma and ocular tension.)

Trantar, N. G. **Coronal capsular striation of the lens.** Ophthalmologica, 1941, v. 101, Feb., p. 82.

The author describes a very delicate coronal radial striation in the lens occurring as a normal phenomenon chiefly in the young. The striations, which are for the most part superficial but also enter into the deeper strata of the cortex, disappear with age.

F. Herbert Haessler.

10

RETINA AND VITREOUS

Amsler, Marc. **Repair of retinal tears.** Ophthalmologica, 1941, v. 101, March, p. 158.

The localization of the retinal tear remains a particularly important phase in the treatment of retinal detachment.

After ten-years experience, the author advocates careful localization according to the method of Gonin as though no ophthalmoscopic control during operation were contemplated. Gonin's method consists of a mark on the limbus, a thread to mark direction, and a scleral mark. Then during the operation Amsler advocates checking on the previous mark with ophthalmoscopic illumination as done by Weve. To avoid fluid loss and hypotony he uses no perforating needle for localization. The diathermy ball is sufficient.

F. Herbert Haessler.

Bakker, A. **Formation of acetylcholine in the retina.** Graefe's Arch., 1939, v. 141, pts. 2 and 3, pp. 326-335.

Stimulation of the oculomotor nerve is followed by liberation of acetylcholine, detected in the fluid of the anterior chamber by Engelhart. Acetylcholine is also supposedly formed in the retina. Stimulation of preganglionic fibers results in acetylcholine production in the synapses, as demonstrated by experimental means. As to the case of the retina, it is not possible to prove this by chemical or biologic examination. In explanted iris preparations, the pupil is miotic, due apparently to the fact that traumatic stimulation of the cut nerves in the iris tissue results in a high concentration of acetylcholine. After several days the pupil dilates. This dilatation of the pupil occurs much later if the retina is also explanted. The author believes that acetylcholine is still being formed in the retina after its formation has ceased in the iris. Isolation of the retina from the choroid gives the same results, suggesting that the choroid does not produce the acetylcholine-like material. The acetylcholine produced by the explanted retina is due to the functioning of surviving nerve cells. If this formation were due to dying tissue, acetylcholine production would increase, instead of decreasing as it does in the experiments. Acetylcholine formation is of great importance in the normal transmission of sitmuli from one neuron to another. In the retina, the transmission of nerve stimuli is effected by liberation of acetylcholine in the synapses.

Charles A. Perera.

Brown, W. M. **Treatment of retinitis pigmentosa with retrobulbar injections of atropine sulphate.** Arch. of Ophth., 1941, v. 25, May, pp. 819-826.

Retrobulbar injections of 0.1-percent atropine sulphate have apparently been of some benefit in cases of retinitis pigmentosa, since of six patients treated in this manner and followed for two years, two showed definite improvement and the condition was apparently arrested in one. Three showed no improvement. Perimetric charts before and after the treatment are included with the case reports.

J. Hewitt Judd.

Dann, W. J., and Yarbrough, M. E. **Dark adaptometer readings of subjects on a diet deficient in vitamin A.** Arch. of Ophth., 1941, v. 25, May, pp. 833-838.

After five weeks on a diet deficient in vitamin A, two subjects failed to show night blindness measurable by the dark adaptometer of Hecht and Schlaer. This finding is discussed, together with others recorded in the literature, and the conclusion is drawn that the dark adaptometer is not at present a reliable indicator of slight degrees of avitaminosis A.

J. Hewitt Judd.

Dax, E. C. **Retinitis pigmentosa.** Quarterly Jour. Med., 1940, v. 9, Oct., pp. 263-307.

Eleven cases of retinitis pigmentosa, all encountered in a mental institution, are reported in detail. The study is largely concerned with the clinical pathology of the condition, particularly from the standpoint of correlating abnormalities which might be attributed to diencephalic disturbance. Skeletal deformity and disturbance, melanosome dispersion in the frog by blood and urine, headache, hyperthermia, hypogenitalism, hypercholesterolemia associated with obesity, diminished glucose tolerance, disturbances of water-salt metabolism, lymphocytosis, and diminished vitamin-C excretion are among the abnormalities which were common to several cases. The results are discussed and an attempt is made to interpret them on the basis of varying degrees of degeneration in the central nervous system. T. E. Sanders.

Friedman, Benjamin. **Mechanics of optic-nerve traction on the retina during the ocular rotation.** Arch. of Ophth., 1941, v. 25, April, pp. 564-575.

The question of optic-nerve traction on the retina at the extreme limits of ocular rotation is considered as a problem in descriptive geometry, using idealized and averaged data. The calculated length of the optic nerve is 34 mm., with 5.0 mm. of slack in the primary position. In extreme abduction the nerve and the portion of the retina nasally adjacent to it must together stretch 0.75 mm. In extreme adduction the nerve and the portion of the retina temporally adjacent to it must together stretch 1.25 mm. These figures are subject to revision in the light of more data concerning the center of rotation. Entoptic evidence is presented that the portion of the retina adjacent to the upper border of the disc is under particular stress during these lateral movements. These observations have been correlated with the predominant locations of tears in cases of retinal detachment, and an attempt has been made to establish a clinical relation.

J. Hewitt Judd.

Gerasimenko, T. H. **Angioid streaks.** Viestnik Opht., 1940, v. 17, pt. 5, p. 632.

The author reviews the literature and reports a case in which there was no xanthomatosis of the skin, nor disturbance in cholesterin metabolism.

Ray K. Daily.

Jaeger, A. **Physiology and pathology of the pulsation of the retinal veins.** Münch. med. Woch., 1940, v. 87, Oct., pp. 1083-1085.

Venous pulsation in the retina depends upon the ratio of intracranial pressure and intraocular pressure and not upon the absolute height of either. An interesting and diagnostically valuable finding is unilateral retinal venous pulsation. The author reports six patients in whom this type of pulsation was present, and subsequent neurologic examination and autopsy showed that an intracranial lesion was in each case located on the side opposite to the venous pulsation. This should prove a valuable localizing sign in cases of early intracranial lesions.

Bertha A. Klien.

Loewenstein, A., and Steel, J. **Retinal tuberous sclerosis (Bourneville's disease).** Amer. Jour. Ophth., 1941, v. 24, July, pp. 731-741.

Mexina, F. M. **Clinical observations on the frequency of persistent hyaloid membrane.** Viestnik Opht., 1940, v. 17, pt. 5, p. 617.

Mexina examined 856 patients, of whom 177 were newborn, 453 were be-

tween 4 and 12 years of age, and 226 were adults. The tabulated data show that most of the tunica vasculosa lentis disappears during intra-uterine life; the process of regression continues through infancy and childhood and into adult life. The author does not agree with Lepage that the arrest of the regressive process is caused by syphilis. (Illustrations.) Ray K. Daily.

Michaelson, I. C., and Campbell, A. C. P. **The anatomy of the finer retinal vessels, and some observations on their significance in certain retinal diseases.** Trans. Ophth. Soc. United Kingdom, 1940, v. 60, p. 71.

The authors describe the retinal circulation as studied with a special preparation. The arterial and venous capillaries connect with both superficial and deep networks, the deeper capillary net being in general a denser and more complex one and the two nets being most easily demonstrated in the equatorial zone.

The basic two-layered pattern of retinal vessels is considerably modified in the posterior, thicker part of the retina. It becomes three-layered in the macular region. In and around the papilla, where the nerve-fiber layer is thick, another more superficial capillary net is present, so that there are four capillary nets at four different levels. In the macular area, the fovea is completely avascular. Toward the periphery of the retina the mesh of the capillary nets becomes wider and the periarterial space increasingly prominent. Eventually the two-layered pattern becomes intermittent, the deep net being present only around the venae efferentes. Still further toward the periphery the deep net disappears entirely and there is only a single net of wide-mesh and wide-caliber capillaries which joins the terminations of the arteries and the veins. There are no anastomoses with the vessels of the ciliary body.

Measurement of the width of the capillary mesh was found possible only in those parts which were two-dimensional. These areas were projected at a magnification of ×375, the capillaries were traced on paper, and numerous measurements of the width of the mesh were made at various points.

A description of vascular lesions, especially with regard to hemorrhages and exudates, is given for the conditions of hypertension, nephritis, diabetes, central venous thrombosis, and papilledema. Beulah Cushman.

Muskhelishvili, S. V. **The pressure in the central retinal vein.** Viestnik Opht., 1940, v. 17, pt. 5, p. 604.

A review of the literature and a report of the author's own studies, which show that calculation of intracranial pressure on the basis of the pressure in the central retinal vein, as proposed by Baurman, Sobanski, and Kukan, does not give accurate data. In 34 cases the calculations thus made were checked by lumbar puncture and failed to indicate the existing intracranial pressure. Ray K. Daily.

Rea, R. L. **Treatment of thrombosis in the central vein of the retina with heparin.** Arch. of Ophth., 1941, v. 25, April, pp. 548-551; also Trans. Ophth. Soc. United Kingdom, 1940, v. 60, p. 213.

Five patients were treated during the past year. Of three cases with complete trunk thromboses, only one was a complete failure, the eye becoming glaucomatous and blind. In the remaining two cases some improvement was evident. In the two cases with branch

thromboses, complete cure resulted. The author also advocates the use of heparin in cases of extensive hemorrhages into the retina or the vitreous. Ambulatory patients may have two injections daily, each of 100 to 125 mg. The needle should not be too small, and slight pressure should be applied to prevent the escape of noncoagulable blood into the subcutaneous tissues.

J. Hewitt Judd.

Sag, H. O. **Ophthalmodynamometry in the study of the retinal circulation.** Viestnik Opht., 1940, v. 17, pt. 5, p. 533.

A description of an ophthalmodynamometer manufactured in the Ukraine Ophthalmologic Institute. (Illustrations.) Ray K. Daily.

Samoilov, A. I., Fedorov, H. T., and Davidov, V. G. **Study of retinal edema by means of the changes in electric retinal sensitivity.** Viestnik Opht., 1940, v. 17, pt. 5, p. 519.

A detailed report of a study of the adaptation curve of retinal sensitivity to flickering light in patients with fresh and with old tuberculous choroiditis. The data show that retinal edema has a definite effect on the adaptation curve to flickering light, and the effect is proportional to the intensity of the edema; the adaptation curve may therefore serve as an indicator of the degree of retinal edema. Fedorov believes that the sensitivity to flickering light depends on the integrity of the retinal synapses, the deviation in the adaptation being caused by some disturbance at these junctions. Retinal edema disturbs the contact between the neurones and interferes with the normal sensitivity to the recognition of the flicker. The adaptation curve of tuberculous choroiditis indicates the presence of retinal edema. It appears therefore that the perifocal inflammation producing the edema is not limited to the retinal layers adjacent to the choroid but extends as far as the synapses. Ray K. Daily.

Yudkin, Simon. **A new dark-adaptation tester.** Brit. Jour. Ophth., 1941, v. 25, May, pp. 231-236.

The instrument described is designed to test the rate at which the eye recovers its power to distinguish a faintly lighted object following a period in which it has been subjected to strong illumination, and to determine visibility after complete adaptation. The nine parts of the simple apparatus are described and illustrated. Procedures for carrying out the test are then presented. The following advantages are attributed to the instrument: (1) Both bleaching and testing may be done with the same instrument. (2) The bleaching tube insures bleaching of the whole retina. (3) The test object may be changed in order to verify the subject's statements. (4) The "polaroid" screens allow fine adjustments of illumination. Use of the instrument with night-blind cases will be reported shortly. (References, figures.)

D. F. Harbridge.

Zorab, E. C. **Surgical cure of an unusual detachment of the retina.** Brit. Jour. Ophth., 1941, v. 25, May, pp. 229-231.

In this case the tear involved more than half the circumference of the retina and was folded in so that the posterior surface faced anteriorly. The right eye was the one affected, sight of the left eye having previously been lost by retinal detachment. The patient was kept in bed for three days lying on the affected side and was then operated upon in this position, the Weve tech-

nique being employed. Results were beyond expectation, and the patient (a priest) returned to his duties. His letters showed no evidence of visual impairment. D. F. Harbridge.

11

OPTIC NERVE AND TOXIC AMBLYOPIAS

Bamford, C. H., and Barber, H. **Blindness following hematemesis.** The Lancet, 1940, v. 239, Dec. 7, p. 715.

The authors report a case of complete blindness from secondary optic atrophy following two attacks of severe hematemesis associated with peptic ulcer. T. E. Sanders.

Cosgrove, K. W., and McCall, E. F. **Retrobulbar injections of atropine sulphate for atrophy of the optic nerve.** Arch. of Ophth., 1941, v. 25, May, pp. 814-818.

Injection of a 0.1-percent aqueous solution of atropine sulphate into the retrobulbar space twice weekly in doses increasing from 0.3 c.c. to 1 c.c. was used in five patients. In two cases of syphilis of the central nervous system of long standing, no improvement was noticed after twenty injections in each eye. In three cases of early atrophy following syphilitic optic neuritis, this treatment was especially effective, and the improvement in vision has remained stationary. The authors conclude that the increase in the blood supply to the optic nerve produced by these injections apparently does improve vision to some degree in cases of atrophy of the optic nerve.

J. Hewitt Judd.

Good, Palmer. **Choked discs in lead encephalopathy.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 794-797.

Lijo Pavia, J. **The eyeground in sodium light in cases of optic atrophy.** Rev. Oto-Neuro-Oft., 1941, v. 16, May, p. 105.

An illustrative description of the eyeground in cases of optic atrophy as viewed in sodium light.

Lijo Pavia, J. **The eyeground in sodium light in cases of pituitary disease.** Rev. Oto-Neuro-Oft., 1941, v. 16, April, p. 73.

A description of the optic-nerve head in four cases of pituitary tumor.

Samuels, Bernard. **Drusen of the optic papilla.** Arch. of Ophth., 1941, v. 25, March, pp. 412-423; also Trans. Amer. Ophth. Soc., 1940, v. 38, p. 322.

A résumé of the microscopic study of preparations from twenty globes in which drusen of the papilla were found is presented, and the anatomic and clinical features correlated. Data are presented as to location, number, size and structure, reasons for enucleation, age of the patient, epipapillary drusen, origin of the drusen of the papilla, pigmented and nonpigmented circumpapillary drusen, and circumpapillary thickening of the lamina vitrea. Some practical points relative to age and the distribution, depth, presence or absence of pigment, are discussed, as well as the relation between drusen and vision, and growth and prognosis. (Bibliography, discussion.) J. Hewitt Judd.

Turner, J. W. A. **Optic atrophy associated with pernicious anemia.** Brain, 1940, v. 63, Sept., p. 225.

Three cases of visual failure due to primary optic atrophy occurring in the course of pernicious anemia are described, and the literature is reviewed. If adequate treatment is given in the early stages, the prognosis is good.

T. E. Sanders.

Veltitzev, F. **Atrophy of the optic nerves in Graves's disease.** Viestnik Opht., 1940, v. 17, pt. 4, p. 492.

A woman 48 years old with exophthalmic goiter developed atrophy of the optic nerves, with vision reduced to 0.08, within six months after the onset of the illness. Five months after thyroidectomy vision was restored to normal, but the optic discs remained pale.

Ray K. Daily.

12

VISUAL TRACTS AND CENTERS

Adrogué, Esteban. **Contribution to the study of cortical hemianopsias.** Arch. de Oft. de Buenos Aires, 1939, v. 14, Oct., p. 919.

Two cases of cortical hemianopsia are reported. The first case exhibited the thalamic syndrome of Déjérene and Roussy, with hemianopsia due to lesion of the posterior cerebral artery. The visual fields, in which the right inferior quadrant was preserved, pointed to involvement of the deep portion of the calcarine fissure and the lingual lobe. The second case was of a gunshot wound of the head, with the missile lodged behind the right wings of the sphenoid near the temporal fossa. The visual fields revealed a right bilateral homonymous hemianopsia with a partial homonymous hemianopsia of the left upper quadrants. The lesion possibly involved the lower portion of the right occipital lobe, destroying the posterior part of the inferior lip of the calcarine fissure and the lower macular fibers.

Plinio Montalván.

Bender, M. B., and Kanzer, M. G. **Metamorphopsia and other psychovisual disturbances in a patient with tumor of the brain.** Arch. Neur. and Psych., 1941, v. 45, March, p. 481.

Psychovisual disturbances in a 57-year-old male with brain tumor are described. The symptoms were lilliputian hallucinations, visual inattention, metamorphopsia, micropsia, macropsia, and sensomotor incoördination of the visual functions. Psychologic aspects of these visual disorders are discussed.

Theodore M. Shapira.

Hemphill, R. E. **Sudden blindness of cortical origin as the result of a cerebral vascular lesion.** Irish Jour. Med. Science, 1941, Jan. p. 28.

Two cases of total blindness of cortical origin are reported. In one an embolus occluded both posterior cerebral arteries at the point of their origin. In the other case, a thrombosis occurred at the origin of the right posterior cerebral artery. This clot spread along the circle of Willis to the left side, blocking the left posterior and left middle cerebral arteries, and causing a stroke with total blindness and a right hemiplegia.

Edna M. Reynolds.

Lebensohn, J. E. **The eye and sleep.** Arch. of Ophth., 1941, v. 25, March, pp. 401-411.

Ludwig Mauthner, an ophthalmologist, discovered the sleep-regulation center in the hypothalamus. Excitability of this area producing wakefulness is maintained by peripheral stimulation. A great reduction of impulses is followed progressively by lowering of sympathetic tone, depression of cortical activity, and sleep. Impaired sympathetic function in drowsiness is evidenced by drooping lids, dry eyes, and congested conjunctiva. A similar syndrome in cases of intractable conjunctival asthenopia, commonly called chronic catarrhal conjunctivitis, suggests that the underlying cause is like-

wise an impairment of sympathetic function. Often a low basal metabolic rate is present and the ocular condition is relieved by administration of small doses of thyroid as shown in the six cases reported. J. Hewitt Judd.

13

EYEBALL AND ORBIT

Davis, L., and Martin, J. **The pathogenesis and treatment of unilateral exophthalmos.** Surg., Gyn., and Obstet., 1941, v. 72, March, pp. 557-567.

Of 15 neurosurgical patients with unilateral exophthalmos, six had intracranial tumor, four meningioma, one glioma of the optic nerve, and one case was unclassified. Four had aneurysms, three of the pulsating carotid-cavernous sinus type and the fourth a bleeding aneurysm of the intracranial part of the internal carotid artery. In three patients transfrontal exploration of the orbit revealed no lesion, while two refused operation. T. E. Sanders.

Doherty, W. B. **Orbital implants.** Arch. of Ophth., 1941, v. 25, April, pp. 637-642.

Since most of the substances used as implants in the orbit are unsatisfactory because of weight, shrinkage, and erosion or necrosis of adjacent tissues, vitallium spheres were tried, this metal being entirely inert in the presence of biologic salt, and having a low specific gravity. It is stronger and cheaper than gold and can be boiled. A dimpled, globe-shaped implant is advocated, as it gives the best cosmetic result with the least limitation of motion. (Bibliography.) J. Hewitt Judd.

Grancini, Enrico. **Xanthomatosis of the eyeball.** Bollettino d'Ocul., 1940, v. 19, Feb., pp. 89-120.

A man of 28 years had at the age of 16 lost the vision of the left eye following trauma. This eye showed a marked pericorneal injection and a yellowish-pink discoloration of the contents of the anterior chamber. The patient also had high blood pressure and hypercholesterinemia. The histologic and histochemical changes, which are described in detail, show that the eye changes were related to the cholesterin lipoidosis. (Bibliography, 14 figures.) M. Lombardo.

Reinus, A. M., and Sharkovski, I. A. **An unusual case of exophthalmos.** Viestnik Opht., 1940, v. 17, pt. 4, p. 489.

A man 23 years old complained of an intermittent exophthalmos of the right eye of eight-years duration. The eye could be made to protrude by pressing on the soft tissues of the cheek. No bony defects could be demonstrated roentgenologically or at operation, which exposed the maxillary antrum through the canine fossa and an incision over the cheek. After healing of the wound the exophthalmos disappeared. The author attributes the exophthalmos to an anastomosis of the facial and orbital veins. (Illustrations.) Ray K. Daily.

Sikharoulidze, I. A. **Clinical characteristics of orbital phlegmons.** Viestnic Opht., 1940, v. 17, pt. 5, p. 629.

A hematogenous infection caused by grippe was treated by incision and drainage. Atrophy of the eyeball resulted. Microscopic section of the mucosa of the nasal sinuses was negative. Ray K. Daily.

Traugh, G. H., and Maxwell, J. S. **Arteriovenous aneurysm.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 800-803.

14

EYELIDS AND LACRIMAL APPARATUS

Agnello, Francesco. **A case of oriental button of the eyelid.** Rassegna Ital. d'Ottal., 1940, v. 9, March-April, pp. 282-293.

A 33-year-old soldier, serving in North Africa, presented a typical picture of oriental sore of the right upper eyelid, which cleared up under application of 3-percent silver nitrate and yellow oxide of mercury. Typical Wright bodies were recovered from the secretion. The author discusses the presence of leishmaniasis in Africa and the differential diagnosis. (2 figures.)

Eugene M. Blake.

Elliot, A. J. **Streptothricosis of the lacrimal canaliculi.** Amer. Jour. Ophth., 1941, v. 24, June, pp. 682-686.

Lehrfeld, Louis. **The eyelids and conjunctiva as shock tissues in allergy.** Dis. Eye, Ear, Nose and Throat, 1941, v. 1, April, p. 100.

Reference is made to the early use of the eye, particularly the conjunctiva, in allergic tests. Sensitization of the skin of the lids to vegetable poisons, cosmetic chemicals, and foods is discussed, and treatment suggested. Vernal conjunctivitis as a specific form of ocular allergy is dealt with at considerable length, including pathology, diagnosis, and treatment. Physical allergy to light is referred to as a newly recognized form of allergy. The author recommends tinted lenses for light tolerance in such cases. F. M. Crage.

MacMillan, J. A. **Prevention and treatment of lacrimation.** Canadian Med. Assoc. Jour., 1941, v. 44, March, p. 284.

The anatomy and physiology of the lacrimal apparatus are described. The pathologic conditions causing excessive lacrimation are discussed, and the proper management of these conditions is outlined. T. E. Sanders.

Nikolaeva, M. C. **Marcus-Gunn syndrome.** Viestnik Opht., 1940, v. 17, pt. 4, p. 487.

A report of a case.

Radnót, Magda. **An adenoma-like hyperplasia of the wall of the lacrimal sac consisting of oncocytes.** Ophthalmologica, 1941, v. 101, Feb., p. 95.

In a 66-year-old woman with trachoma and chronic dacryocystitis, the author observed a mass which on histologic examination proved to be an adenoma-like hyperplasia consisting of oncocytes. These cells arise from the epithelium of folds in the mucosa and numerous mitotic figures are in evidence. F. Herbert Haessler.

Robbins, A. R. **A surgical treatment of spastic entropion.** Arch. of Ophth., 1941, v. 25, March, pp. 475-476.

Under local anesthesia an external canthotomy is done. The outer third of the lower lid is pulled forward and downward to make the lateral attachments taut. Straight scissors are introduced downward at the margin of the canthotomy wound, the points entering between the conjunctiva and the skin. The muscle attachments and the fascias are severed downward for 1 to 2 cm. until the lid feels lax. Two silk skin sutures are used to close the wound. The needle is passed through the skin of the upper lid, without including the conjunctiva, then through the conjunctiva of the lower lid, and emerges, without including skin. The lips of the wound are approximated and tied. This results in a slight eversion of the lower lid. J. Hewitt Judd.

Rosenbaum, J. **Boeck's sarcoid of the lacrimal gland.** Arch. of Ophth., 1941, v. 25, March, pp. 477-482.

A woman aged 26 years had asymmetric enlargement of the lacrimal glands. After excision of the right lacrimal gland there was a distinct diminution in the size of the corresponding gland on the left side over a period of about four months. Within three to four months there was enlargement of the glands of the axillary, inguinal, and cervical regions. Biopsy of a gland in the neck and a lacrimal gland showed small tubercle-like areas consisting of epithelioid cells and giant cells which suggested Boeck's sarcoid. This condition is relatively benign. (Photomicrographs.)

J. Hewitt Judd.

Sniderman, H. R. **Boeck's sarcoid of the lacrimal gland, with bilateral iridocyclitis.** Amer. Jour. Ophth., 1941, v. 24, June, pp. 675-680.

Thompson, Richard. **Lysozyme and the antibacterial properties of tears.** Arch. of Ophth., 1941, v. 25, March, pp. 491-509.

After reviewing the literature the author discusses the action of lysozyme and the factors affecting its concentration, its action on organisms other than the sensitive micrococci, and the part played by lysozyme in the general antibacterial action of tears in the defense of the eye surfaces.

J. Hewitt Judd.

Traquair, H. M. **Contribution to the study of the causation and treatment of chronic dacryocystitis.** Trans. Ophth. Soc. of the United Kingdom, 1940, v. 60, p. 127.

In a study of 548 adult cases of tearing from the Royal Infirmary of Edinburgh almost 50 percent were dacryocystitis. The author describes the primary and secondary forms. The primary form is common, seems to be hereditary in origin, and occurs in women to the extent of 80 percent. The secondary form is rare, is due to injury or disease of the neighboring parts, and occurs approximately equally in the two sexes. The most satisfactory treatment is a drainage operation, such as an external dacryocystorhinostomy.

Beulah Cushman.

15

TUMORS

Biró, Imre. **Metastasis of breast carcinoma to the orbit, with enophthalmos.** Orvosi Hetilap, 1941, v. 85, no. 2, p. 19.

A 41-year-old woman complained of double vision, ptosis, and stiffness in the right eye. The eyelids appeared swollen and red but not inflamed. Slight ptosis and an enophthalmos of 3 mm. were noted. The eyeball was restricted in its upward and outward movements and a massive resistance was felt on its reposition. Both fundi were negative. The author assumed that the findings were due to carcinoma metastasis, since both breasts had been amputated for carcinoma within the previous year. Four months later the patient returned for reexamination. At that time the lids were already adherent to the orbital margin and the latter was rough to palpation. The lower eyelid could not be pulled down, nor the upper eyelid everted. In the vicinity of the amputation scar a mass could be felt which was not present at the previous examination. R. Grunfeld.

Csapody, István. **Retinal tumor operated upon by diathermy.** Orvosi Hetilap, 1941, v. 85, no. 12, p. 147.

The patient was a woman of fifty-one years. Exactly in the macular region a small, brownish, obliquely oval tumor, apparently a melanosarcoma, was seen protruding to the height of one diopter. Pigment granules were scattered upon the surface of the tumor, which was surrounded by a narrow halo of atrophic retina. Because the patient refused enucleation, the author destroyed the tumor by means of diathermy coagulation, first isolating it by two encircling rows of coagulation points. After all vessels were obliterated and an edema barrier produced, the tumor itself was destroyed by ignipunctures. Three months later nothing was seen of the tumor, but in its place was a cicatrix and a flatly detached retina. Vision was nil. R. Grunfeld.

Dudinov, O. A. **Neoplasms of the choroid.** Viestnik Opht., 1940, v. 17, pt. 5, p. 609.

In a case of a perforating melanosarcoma of the choroid in an atrophic eyeball, the microscopic picture indicated that the atrophy preceded the development of the neoplasm. This case points to the advisability of removing all atrophic eyes. Another case reported was that of a slightly pigmented choroidal sarcoma with retinal detachment and breaking through of the neoplasm into the vitreous. Newformed vessels on the iris appeared early in the development of the tumor. An unusual feature was the presence, on microscopic section, of a benign epithelioma in the ciliary body.

Ray K. Daily.

Fry, W. E., and DeLong, P. **Psammoma of the orbit.** Amer. Jour. Ophth., 1941, v. 24, June, pp. 664-668; also Trans. Amer. Ophth. Soc., 1940, v. 38, p. 87.

Imre, Harry. **Dictyoma in an early stage.** Arch. of Ophth., 1941, v. 25, April, pp. 629-636.

The author reviews the literature briefly and reports the case of a boy aged two years, in whom a dictyoma associated with cataract and secondary glaucoma was found at a relatively early stage. The eye was enucleated and studied histologically. The cells of the solid-cell masses appeared to be more malignant than those of the cellular bands, and at some places the cells of the solid-cell group broke through the cellular bands to infiltrate the sclera and the cornea. Although dictyoma is a malignant tumor of the ciliary epithelium which has the structure of the embryonic retina, the relation of dictyoma to retinal glioma is not clear. The findings are clearly shown in photomicrographs. J. Hewitt Judd.

Kaye, Herbert. **Treatment of angiomatosis retinae.** Arch. of Ophth., 1941, v. 25, March, pp. 443-444.

Two cases are reported in each of which treatment by a combination of catholysis and surface diathermy caused the retinal tumor to completely disappear, leaving a pigmented area of atrophy similar to that seen after diathermy operations for retinal detachment. The treatment described is recommended for the type of vascular tumor characterized by a single nodule located far forward. The object of the treatment is to produce by catholysis obliterative endarteritis of the large dilated quadrant branch of the retinal artery which feeds the mass of angiomatous tissue, and also of the companion vein. The growth is also treated by catholysis and surface diathermy and even diathermy punctures.

J. Hewitt Judd.

Kosnun, V. I. **Melanocarcinoma of the choroid with multiple metastasis.** Viestnik Opht., 1940, v. 17, pt. 4, p. 491.

A report of a case of malignant melanoma of the choroid with fatal outcome in a man 47 years old. There had been metastasis to the brain and internal organs within six months.

Ray K. Daily.

Koyanagi, Y. **A contribution to the pathologic anatomy and pathogenesis of rodent ulcer of the cornea.** Graefe's Arch., 1940, v. 141, pts. 4 and 5, pp. 358-373. (See Section 6, Cornea and sclera.)

Pahwa, T. R. **Prognosis in sarcoma of the uvea.** Brit. Jour. Ophth., 1941, v. 25, June, pp. 241-286.

The author first discusses his method of procedure in cases studied, and then deals with the histology and prognosis. Cases reported are divided into two groups: (1) those living more than five years after operation; (2) those living from three to five years after operation. Histologic types are graded into three groups of malignancy, and a series of tables presents the prognosis of sarcoma of the iris. (Photomicrographs, tables, references.)

D. F. Harbridge.

Paltzeva, Z. A. **Two cases of chloroma of the orbit.** Viestnik Opht., 1940, v. 17, pt. 5, p. 651.

A review of the literature and a report of orbital involvement in two fatal cases. The etiology could not be established in one case; in the second case the symptoms appeared two weeks after an injury. The ocular symptoms were exophthalmos and retrobulbar optic neuritis. (Illustrations.)

Ray K. Daily.

Riwchun, M. H., and DeCoursey, E. **Sympathetic ophthalmia caused by nonperforating intraocular sarcoma.** Arch. of Ophth., 1941, v. 25, May, pp. 848-858.

A review of the literature revealed four authentic cases in which sympathetic ophthalmia apparently was due to a sarcoma without injury or perforation of the eye. A fifth case is reported in detail, in which there was a mixed epithelioid-cell and spindle-cell subtype-B malignant melanoma of the choroid with invasion of the retina and the vitreous; secondary absolute glaucoma; sympathetic ophthalmia; cataract secondary to tumor growth with detachment of the retina. There is no explanation of the exact factor responsible for sympathetic ophthalmia in this series of cases.

J. Hewitt Judd.

Sie-Boen-Lian, B. L. **Carcinoma of the meibomian glands in Batavia.** Ophthalmologica 1941, v. 101, April, p. 205.

Only eighty cases of carcinoma of the meibomian gland have been reported previously. The author observed nine between 1934 and 1940. In eight of these the tumor remained localized in the lid. In one it filled the entire orbit and had metastasized to the preauricular gland. The mass varied from the size of a nut to that of a hen's egg and usually was ulcerated when first seen. Most of the patients were women and all were over forty years of age. Microscopically most of the tumors were adenocarcinoma in which the cells had the structure and arrangement of sebaceous gland tissue and stained with Sudan III.

Therapeutically, extirpation is indicated. In one of the author's patients there was recurrence in 3½ years, and

in another patient the orbit was exenterated. F. Herbert Haessler.

16
INJURIES

Albers, E. C. **Blackberry thorn in the anterior chamber of the eye for 12 years.** Arch. of Ophth., 1941, v. 25, April, pp. 662-663.

Injury by a blackberry thorn 12 years before had produced a severe inflammation lasting about a month and resulting in blindness to the eye. At the time of examination the eye was free from inflammation, but presented a glistening, brown, tapering lunate thorn 4 mm. long, attached by a small amount of fibrous tissue to the posterior aspect of the scar at Descemet's membrane. The thorn was completely surrounded by aqueous and did not touch the iris or the lens. The pupil was very small and bound down to the cataractous lens. Light perception and projection were good.

J. Hewitt Judd.

Bangerter, A. **A simplified accurate method of localization of intraocular foreign body.** Ophthalmologica, 1941, v. 101, March, p. 139.

The author describes his technique for localization of intraocular foreign bodies. He recommends it not only because it is simpler than most methods, but also because it is more accurate. Any available X-ray apparatus can be used. The films are very small and are held in place by hand. The only accessory needed is an inexpensive aluminum ring, of the same diameter as the cornea, in which are four tiny steel pins, so bent that they hook the ring into the tissue of the limbus. Before applying the ring to the eye the hooks are dipped in India ink so that they will leave tiny tattoo marks that help in orientation. Fronto-occipital and lateral exposures are made. The distances from the shadows of the foreign body to that of the ring are easily transferred to the eye because of the tattoo marks. F. Herbert Haessler.

Belousova, P. V. **Two cases of vitreous detachment.** Viestnik Opht., 1940, v. 17, pt. 4, p. 488.

A report of two cases of traumatic posterior vitreous detachment. A clear opening of limited motility, through which were seen the central retinal vessels, and the adjacent cloudiness, indicated the diagnosis.

Ray K. Daily.

Brodskili, B. S. **Data on electromagnetic operations in the eye clinic of the Odessa Medical Institute.** Viestnik Opht., 1940, v. 17, pt. 5, p. 675.

An analysis of 31 cases. The conclusions are that prompt extraction improves the prognosis. The management of each case has to be individualized with the character and location of the foreign body. Hospitalization was somewhat shorter following extraction by the anterior route.

Ray K. Daily.

Butler, T. H. **Anomalies at the posterior pole of the lens.** Trans. Ophth. Soc. United Kingdom, 1940, v. 60, p. 113.

As an addendum to a previous article (Amer. Jour. Ophth., 1938, v. 21, p. 951) Butler reports the findings in a case of scleral rupture. The face of the vitreous showed striations, and streaks of blood were plainly visible. (Illustrations.) Beulah Cushman.

Friedman, Benjamin, **Subconjunctival hemorrhage as a sign of double perforation of the globe by a foreign body.**

Arch. of Ophth., 1941, v. 25, April, pp. 672-673.

A case is reported illustrating that the simultaneous existence of a fresh perforating wound in the cornea and a subconjunctival hemorrhage should excite the suspicion that the foreign body is outside rather than inside the globe and that it lies underneath the hemorrhagic spot. This sign is of value when accurate roentgen localization is unattainable. J. Hewitt Judd.

Goldman, H., and Bangerter, H. **The localization of intraocular foreign bodies.** Ophthalmologica, 1941, v. 101, April, p. 215. (See essay by Bangerter.)

Kalfa, C. F., and Brodskii, B. C. **Magnet of an iron-nickel-aluminum alloy for the extraction of intraocular foreign bodies.** Viestnik Opht., 1940, v. 17, pt. 4. p. 456.

The author has designed a magnet which is lighter, superior in effectiveness, and easier to manipulate than the electromagnet. Ray K. Daily.

Lijo Pavia, J. **The eyeground in sodium light following injury with loss of an eye.** Rev. Oto-Neuro-Oft., 1941, v. 16, Jan., p. 13.

A description of the fundi in three cases of penetrating wound of the globe as viewed by sodium-light ophthalmoscopy with particular reference to the appearance of the macular region. Edward P. Burch.

Lijo Pavia, J. **The eyeground in sodium light in a case of old injury with loss of the eye and lesions in the fundus of the other eye.** Rev. Oto-Neuro-Oft., 1941, v. 16, Feb.-March, p. 41.

Description of the fundi in cases of injury of long standing as viewed by ordinary, red-free, and sodium light.

Machlin, I. M. **Shift in the conjunctival flora of rabbits in lye burns.** Viestnik Opht., 1940, v. 17, pt. 4, p. 422.

A detailed report is given of a laboratory investigation on the conjunctival sacs of rabbits, which normally contain no pathogenic microörganisms. The data show that the necrosis of tissue caused by lye creates a favorable medium for the growth of purulent microorganisms, which gradually increase in number during the first seven days after the burn. Ray K. Daily.

Medvedjev, H. I., and Zolotareva, M. M. **Prophylaxis against retinal detachment in diascleral removal of foreign bodies.** Viestnik Opht., 1940, v. 17, pt. 5, p. 582.

The author applies the galvanocautery to the lips of the wound after the foreign body has been extracted. In 32 cases treated in this manner, retinal detachment did not occur. A comparison of these results with previous data justifies the conclusion that cauterization of the lips of the wound acts as a prophylactic against retinal detachment. Ray K. Daily.

Poštić, Svetozar. **Great traumatic enophthalmos with luxation of the lacrimal gland under the conjunctiva.** Ophthalmologica, 1941, v. 101, April, p. 228.

In a cavalry man who was kicked by a horse in the region of the temple, an enophthalmos of 7 mm. and luxation of the lacrimal gland under the conjunctiva were observed. The eye became blind. The author extirpated the lacrimal gland and slightly raised the lid by means of a Hess operation. Luxation of the lacrimal gland under the conjunctival fornix occurs in blepharochalasis and also spontaneously as a congenital and hereditary anomaly but has been

recorded only once before as a result of blunt trauma. F. Herbert Haessler.

Radnót, Magda. **The question of localizing a tear in the retina.** Klin. M. f. Augenh., 1941, v. 106, Jan., pp. 44-47.

In an eyeball enucleated two weeks after a perforating injury a superior detachment of the retina was found, on the highest point of which was a retinal tear. In the choroid a granulation nodule corresponded to the retinal tear, but was 2.5 disc diameters nearer to the limbus than the projection of the tear by ophthalmoscopic examination would have localized it. (3 illustrations.) Gertrude S. Hausmann.

Rosenblum, M. E. **The extraction of metallic splinters from the ciliary body.** Viestnik Opht., 1940, v. 17, pt. 5, p. 667.

A review of the literature and an analysis of 45 cases. In 60 percent of the cases the splinter entered through the cornea, and in 40 percent through the sclera. In 43 cases the splinter was in the inferior portion of the sclera. Removal was accomplished through an incision over the localized splinter, with electrocoagulation of the lips of the wound. Forty-three cases were operated upon, and the splinter was extracted in forty. Vision was improved in 22 cases, remained unchanged in 14, and was diminished in seven. Four eyes were enucleated, in two of which the splinter could not be extracted.

Ray K. Daily.

Spaeth, E. B. **Immediate and late treatment of injuries about the orbit.** Surg., Gyn., and Obstet., 1941, v. 72, Feb. 15, p. 453.

The author discusses in detail the immediate management of fractures of the orbit and lacerations of the lids. Indications for enucleation are outlined. The treatment of oculomotor injuries is described. The late plastic repair of traumatic lid deformities is discussed with description of some of the indicated procedures.

T. E. Sanders.

Tichova, V. A. **Local application of cod-liver oil in ocular burns.** Viestnik Opht., 1940, v. 17, pt. 4, p. 396.

A report of two cases illustrates the author's contention that local use of cod-liver oil alleviates pain, hastens epithelization, and promotes corneal transparency. Ray K. Daily.

17

SYSTEMIC DISEASES AND PARASITES

Angevine, D. M., and Huntington, R. W., Jr. **Experimental ocular tuberculosis in normal and immunized rabbits.** Amer. Jour. Path., 1941, v. 17, March, p. 155.

On the basis of experimental tuberculosis in rabbits the authors found that: (1) the incidence of ocular tuberculosis was closely related to the amount of tuberculosis in the lungs; (2) tubercles were observed most often in the anterior segment and occurred with relative frequency in both the ciliary body and ciliary processes; (3) tuberculosis developed frequently in the eyes of infected rabbits. Immunization preceding infection afforded some protection against the occurrence of ocular tuberculosis.

Theodore M. Shapira.

Bab, Werner. **Allergy of the eye.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 759-767.

Bolettieri, Daniele. **Ocular manifestations of epidemic parotitis.** Bollet-

tino d'Ocul., 1940, v. 19, Feb., pp. 148-166.

Bolettieri reports two cases of parotitis in patients aged 20 and 28 years respectively. The former showed in each eye a cyclitis, and haziness of the deep layers of the cornea, with deposits on Descemet's membrane. The latter showed in each eye marked conjunctivitis, episcleritis, superficial punctate keratitis, and paralysis of accommodation. (Bibliography.) M. Lombardo.

Demole, V., and Knapp, P. **Eye lesions in rats on vitamin-E-free diet.** Ophthalmologica, 1941, v. 101, Feb., p. 65.

In a large number of rats fed on a vitamin-E-free diet ocular changes were frequent. In the young animals, a keratoconjunctivitis appeared at about the time that paralyses became manifest (three weeks after birth). The infrequency of winking resulting from muscle degeneration may have been a factor in the development. In adult rats exophthalmos was very common. The mechanism of the production is unknown. Occasionally a severe general ocular degeneration occurred, characterized by edema, loss of transparency, iritis with vascularization and many eosinophile cells, cataract, and serous inflammation of the retina.

F. Herbert Haessler.

Hou, H. C. **Riboflavin deficiency among Chinese. 1. Ocular manifestations.** Chinese Med. Jour., 1940, v. 58, Dec., pp. 616-628.

Hou reports a series of forty cases of riboflavin deficiency with ocular manifestations observed over a period of three months. The ocular lesions in order of frequency were pericorneal injection, bulbar conjunctivitis, photophobia, vascularization of the cornea, blurring of vision, phlyctenules, corneal opacities, blepharitis, and iritis. The dosage used was 15 mg. daily for the first day or two, then 10 mg. for three to ten days, and finally 5 mg. daily for another week. The first symptom to disappear was usually the photophobia. In less than 48 hours the bulbar conjunctivitis would begin to subside. All symptoms had usually completely disappeared in four or five days.

T. E. Sanders.

Kholina, A., and Chernobilskaja, P. **Carbohydrate metabolism in scrofulous diseases of the eye.** Viestnik Opht., 1940, v. 17, pt. 5, p. 564.

The data were obtained on 32 patients. They show that in scrofulous diseases of the eye the fasting sugar does not exceed normal limits. There is a correlation between the blood sugar and sensitivity to tuberculin. In 93 percent of the cases the sugar-tolerance curve showed a deviation from the normal manifested by a retardation of the drop, which may have been due to an insufficiency of insulin. In the regressive stage of the disease the curve became normal. In resistant cases sugar tolerance should be examined and small doses of insulin administered if necessary. Ray K. Daily.

McKee, S. H. **Fundus oculi in diabetes mellitus.** Arch. of Ophth., 1941, v. 25, May, pp. 773-779.

After listing the cases of ocular pathology found in this series of 2,360 cases, the author discusses the importance of arteriosclerosis in relation to these findings, outlines the diagnostic features characteristic of diabetic retinitis, and reports a case of lipemia retinalis. Since the introduction of insulin, coma has largely disappeared as a cause of death and has been replaced

by cardiovascular disease. Since the only basis for controlling this condition is to detect it in its earlier stages, routine examination of the fundi is a necessity. Arteriosclerotic changes in the finer retinal vessels can be seen long before the roentgen ray shows calcification in the arteries of the feet, and also before there is hypertension, enlargement of the heart, or any other clinical finding of arteriosclerosis.

J. Hewitt Judd.

Veasey, C. A., Jr. **Ocular findings associated with dysostosis multiplex and Morquio's disease.** Arch. of Ophth., 1941, v. 25, April, pp. 557-563; also Trans. Pacific Coast Oto-Ophth. Soc., 1940, 28th mtg., p. 107.

The literature is reviewed and a case reported of dysostosis in a child 18 months of age. Dysostosis multiplex and Morquio's disease are both forms of dwarfism with which ocular defects occur. With either condition there may be apparently large, prominent eyes and an abnormally great interpupillary distance. Points of differentiation are that in cases of Morquio's disease the condition is not manifest until the age of walking; there is a definite familial tendency; genu valgum is frequently present; the skull is normal; and the mentality is good. Ocular defects are infrequent. Dysostosis multiplex is recognized during the first year of life; there is no familial tendency; there are abnormalities of the skull; the cornea is invariably cloudy; and there are usually other ocular defects. The differentiation is of more than academic interest, as in cases of dysostosis multiplex the mentality is almost always impaired. Some of the cases reported as instances of Morquio's disease have probably been cases of dysostosis multiplex.

J. Hewitt Judd.

18

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Berens, Conrad. **Fifty years of ophthalmology in the United States.** Amer. Jour. Surg., 1941, v. 51, Jan., p. 188.

The author presents a résumé of some of the more important advances made by American ophthalmologists in the past fifty years.

Theodore M. Shapira.

Bidyādhar, N. K. **Principles of Suśrutan ocular therapy interpreted in the light of modern ophthalmic science.** Arch. of Ophth., 1941, v. 25, April, pp. 582-628.

The ocular therapeutics as taught by Suśruta in the prehistoric age are reviewed and compared with those of modern ophthalmic science. Many of the metallic and nonmetallic substances used in ophthalmic practice today were first introduced by Suśruta. Among these are gold, silver, copper, iron, zinc, mercury, tin, sodium chloride, and boric acid. Suśruta first discovered the therapeutic efficacy of copper sulphate in trachoma and papillary conjunctivitis, and pioneered the introduction of vitamin therapy in ocular practice, such as the use of liver for night blindness. He introduced antiseptic and antiphlogistic eye washes, eye lotions, compresses, and medicated plasters and ointments, as well as venesection and cauterization. His teaching on the anatomy and diseases of the cornea are in accordance with the teachings of Bowman and modern authorities. Since Suśruta's second corneal layer corresponds to Bowman's membrane, the author suggests that it be called the "Suśruta-Bowman" membrane. Suśruta was the first to advocate the principle of vascular obliteration in the treat-

ment of various forms of keratitis, and he used a magnet to extract foreign bodies from the eye.

J. Hewitt Judd.

Fisher, K. M. **The second edition of Russian stereoscopic pictures.** Viestnik Opht., 1940, v. 17, pt. 4, p. 477.

A description of the pictures. (Illustrations.)

Hayden, Reynolds. **Development and prevention of myopia at the United States Naval Academy.** Arch. of Ophth., 1941, v. 25, April, pp. 539-547.

Results of refractions conducted at the Naval Academy during the past three years lead the author to conclude that it is necessary for midshipmen to have a hyperopic reserve of at least 1 D. at the time of admission to obviate the development of myopia and thus maintain the visual standards of the line of the Navy. J. Hewitt Judd.

Hine, M. L. **Ophthalmology at war.** Trans. Ophth. Soc. United Kingdom, 1940, v. 60, p. 117.

The author reviews experiences in organizing ophthalmic base hospitals in expectation of immediate mass bombing of London and other large centers. The whole hospital service of London was disorganized and in none of the ophthalmic hospitals except Moorfields were in-patient beds available, while most of them had only a skeleton out-patient service. The base hospital was located away from the city in what had been a training college for cripples. Few war victims had been received to date, but the chronic cases of glaucoma, cataract, separated retina, and injury were being transferred from the city. Beulah Cushman.

Holmes, W. J., and Hamman, G. C. **Causes of blindness in Hawaii.** Arch. of Ophth., 1941, v. 25, April, pp. 643-650.

The statistics here reported are based on a recent survey of 379 blind persons, of whom 340 were examined by ophthalmologists. These are discussed as to distribution by age and sex, racial classification, etiologic classification, and topographic classification of the blindness. In the infectious-disease group, syphilis was first, followed by leprosy, trachoma, and gonorrhea. Traumatism was responsible for blindness in only thirty cases.

J. Hewitt Judd.

Irvine, Rodman. **An ocular policy for public schools.** Amer. Jour. Ophth., 1941, v. 24, July, pp. 779-788.

Kuhn, H. S. **A new concept of visual performance in industry.** Sight-Saving Review, 1940, v. 10, Dec., p. 273.

The duties and problems of the industrial ophthalmologist, particularly from the standpoint of prevention, are outlined. Kuhn believes that all employees should have an ocular examination and that all eye defects should be kept in mind when assigning an employee to any particular type of work.

T. E. Sanders.

Maggi Zavalia, Juan. **Organization of the campaign against trachoma in northern Santa Fe.** Arch de Oft. de Buenos Aires, 1939, v. 14, Oct., p. 882.

The history, classification, epidemiology, and prophylaxis of trachoma are discussed. The organization of the campaign against this disease in the province of Santa Fe, as carried out by the Department of Health, is presented in detail. (Maps, illustrations, statistical tables.) Plinio Montalván.

Vancea, P. **Rumanian contributions to the trachoma problem.** Ophthalmologica, 1941, v. 101, March, p. 147.

The author gives an impressive account of the contribution by Rumanian workers to all fields of trachoma study —clinical, pathologic, biologic, chemical, and therapeutic.

F. Herbert Haessler.

19

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Crozier, W. J., and Wolf, E. **The flicker response contour for phrynosoma (horned lizard; cone retina).** Jour. Gen. Physiology, 1941, v. 24, Jan. 20, p. 317.

The lizard phrynosoma, with a purely cone retina, provides a simplex flicker response contour with a normal probability integral. This curve differs markedly from that obtained under the same conditions for the turtle pseudemys, also with entirely cone retina.

T. E. Sanders.

Fortin, E. P. **Observations on the histology of the papilla.** Arch. de Oft. de Buenos Aires, 1939, v. 14, Oct., p. 927.

Fortin states that, contrary to classic teachings and the descriptions in most textbooks, ganglion cells are found in the fovea, from where a direct and straight bundle of nerve fibers runs horizontally to the optic nerve. The author believes that the internal limiting membrane extends over the papilla, but that it is extremely thin in this region. He categorically denies the presence of Müller's fibers in the retina. Cajal's conception that the limiting membranes are formed by the terminal expansions of the so-called Müller's fibers is false and based on artefacts and faulty histologic technique. The "argentic impregnations" are only silver-stain precipitates in the empty, interfibrillar spaces of the nerve-fiber layer of the retina. (Photomicrographs.)

Plinio Montalván.

Musabeili, Y. **Anatomy of the zonular layer.** Viestnik Opht., 1940, v. 17, pt. 4, p. 439.

The author reviews the literature and describes his own material. He concludes that the lens capsule is formed in layers and is not a homogeneous structure. The zonular layer is superficial and forms a continuation of the zonular fibers to which it is related genetically. The frequent detachment of the zonular layer at the equator of the lens is due to the traction of the zonular fibers. Pathologic exudates on the anterior lens capsule and at the pupillary margin have no relation to the detachment of the zonular layer. (Photomicrographs.)

Ray K. Daily.

Wolff, Eugene. **The blood supply to the lamina cribrosa.** Trans. Ophth. Soc. United Kingdom, 1940, v. 60, p. 69.

The author has demonstrated blood supply to the lamina cribrosa from the central artery. He had denied this in an earlier report. He states that this agrees with Leber's belief that there is a capillary anastomosis between the branches of the central artery and those of the circle of Zinn.

Beulah Cushman.

Wolff, Eugene. **The external limiting membrane of the retina and its relation to "Verhoeff's membrane."** Trans. Ophth. Soc. United Kingdom, 1940, v. 60, pp. 61-67.

This contribution verifies Verhoeff's description made in 1933 of a mem-

brane which continues from the external limiting membrane at the margin of the disc and passes into the layer of pigment epithelium where it can be followed until the gradually increasing pigmentation hides it from view. With bleaching this membrane was visible in the pigment layer throughout the fundus. The appearance of the membrane in cross section is that of a delicate line running along near the inner margins of the cells. (Photomicrographs.)

Beulah Cushman.

NEWS ITEMS

Edited by Dr. Ralph H. Miller

803 Carew Tower, Cincinnati

News items should reach the editor by the twelfth of the month

Deaths

Dr. Thomas Aloysius O'Brien, Philadelphia, Pennsylvania, died June 21, 1941, aged 58 years.

Dr. Thomas R. Mullen, Omaha, Nebraska, died April 29, 1941, aged 73 years.

Dr. Stanley Earl Copeland, Worcester, Massachusetts, died May 13, 1941, aged 39 years.

Dr. Andrew Jackson Clay, St. Charles, Missouri, died May 20, 1941, aged 51 years.

Dr. George D. Lockhart, King, Ontario, Canada, died May 17, 1941.

Dr. Thomas C. Seright, Chatsworth, Illinois, died April 29, 1941, aged 79 years.

Dr. William Connolly, Cresco, Iowa, died May 15, 1941, aged 80 years.

Dr. William Thomas Bruner, Louisville, Kentucky, died June 3, 1941, aged 70 years.

Dr. William Alexander Moore, Tacoma, Washington, died May, 1941, aged 63 years.

Dr. Peter Cope White, Tulsa, Oklahoma, died May 26, 1941, aged 51 years.

Dr. Franklin McCue Hanger, Staunton, West Virginia, died June 17, 1941, aged 79 years.

Dr. Olin G. A. Barker, Johnstown, Pennsylvania, died May 28, 1941, aged 69 years.

Dr. Robert Everett Moss, LaGrange, Texas, died May, 1941, aged 83 years.

Dr. Merle E. Scott, Massillon, Ohio, died May 20, 1941, aged 51 years.

Dr. Eugene Smith, Jr., Detroit, Michigan, died May 20, 1941, aged 53 years.

Dr. George W. McCarthy, Kenosha, Wisconsin, died May 22, 1941, aged 71 years.

Dr. John Joseph Heck, Baltimore, Maryland, died May 4, 1941, aged 61 years.

Dr. Edward Wilson Sickel, Baltimore, Maryland, died May 19, 1941, aged 42 years.

Miscellaneous

The 1941 annual meeting of the National Society for the Prevention of Blindness will be held in New York City, December 4th to 6th, it is announced by Mrs. Eleanor Brown Merrill, executive director. The following four new members have been added to the Society's board of directors: Mrs. Julius Ochs Adler, New York City; Miss Edith M. Baker, Washington, D.C.; Dr. Herman E. Hilleboe, St. Paul, Minnesota; and Mr. R. Amory Thorndike, Bar Harbor, Maine. Headquarters are maintained at 1790 Broadway, New York City.

Societies

At the May meeting of the Cleveland Ophthalmological Club, the following officers were elected: Dr. W. J. Abbott, president, and Dr. L. V. Johnson, secretary and treasurer.

Personals

Dr. William Thornwall Davis, professor of ophthalmology of the George Washington University School of Medicine, Washington, D.C., gave three lectures before the Los Angeles County Society of Ophthalmology and Otolaryngology, Los Angeles, California, on July 26, 1941, on the following subjects: (1) Differential diagnosis of squint and the phorias; (2) Treatment of accommodative squint—illustrated with lantern slides; and (3) Disorders of vertical motility—with moving pictures.